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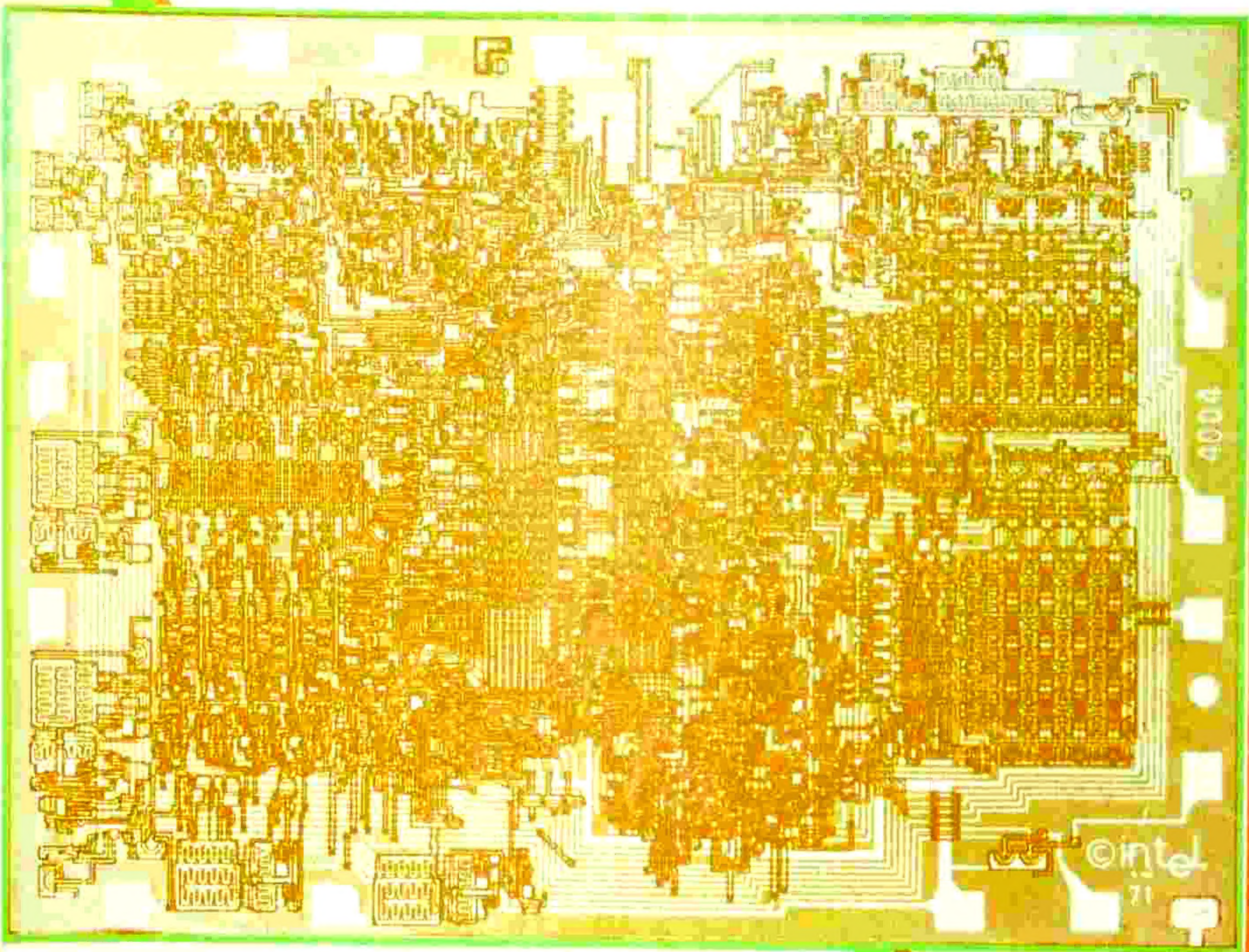
Issue No 9

LECTOR
PERCENTILE DICE



STEREO MIXER
DIGI CHASER
8-watt POWER AMPLIFIER
TRAFFIC LIGHTS FOR MODEL RAILWAYS
VIC-20 CLUB

TALKING ELECTRONICS

Editorial... VOL. 1 No: 9.

Recently we had need to increase our staff. The demands put on the present members of staff were too great. So we turned to the first medium to come to mind. Advertise in the daily paper under Vacancies.
Obviously enough, the response was not astounding. After all, we did not advertise *"$400 per week, NO skill needed"*. We required an electronics expert with a thorough understanding of Digital Principles. Maybe the advert was too vague because we received 40 - 50 calls of which 90% could not describe a 1N 4002, a CD 4017 or a 555!

What has happened to the teaching of electronics?

Some of the applicants said they were attending first or second year electronics courses. How could you go through a year of electronics and not come across a simple power diode?
Fortunately, I know most readers of TE will be saying to themself "why didn't you let me know?" As it happens, the requirements and qualifications would be far and beyond the knowledge already presented in the magazine. . . we are already working on a baby micro-computer for under $100, using the Z80 chip. The understanding of machine language for this project would need to be one of the basic requirements.
So, maybe in a year or so, you will be in the qualifying bracket. Also you would need to live close-by and put up with a room full of non-smokers.
This incident brought home a drastic need. That of a practical digital course in Secondary Schools. We are working on it and in the interim, hope these pages of the magazine will provide a starting point for more students to grasp the basic concepts of electronics.
Never fear, we will be putting out feelers at a later date for design and construction personnel. Watch the papers, you may see our 3 line advert amongst the hoards of "con" adverts, and recognise us by the phone number.

Before I go, don't forget the phone enquiry service. Ring anytime. Lots of readers do. We can help you in a couple of minute if it's an STD call. Also you can order any of the kits and bits by Bankcard over the phone.

Until the next issue with the computer . . . . . .

Colin Mitchell.

TECHNICAL

Ken Stone

ARTWORK

Paul O'Callaghan

ENQUIRIES

10 Minute queries will be answered on 584 2386

ADVERTISING

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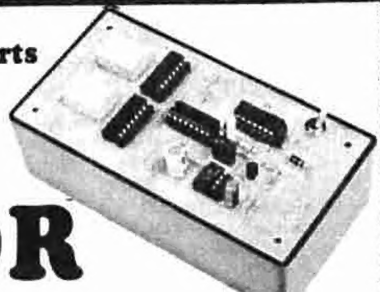
INDEX

Our Cover: Microphoto of an early Intel 4-bit Micro-processor

Ken's Tanya using our LOTTO SELECTOR.

LOTTO NUMBER SELECTOR

$11.50 Parts
$2.95 PC board



USE OUR LOTTO SELECTOR TO WIN A FORTUNE!

This project is a real winner - in more ways than one. When you understand how the circuit works, it is really 4 projects in one. And it has two modes of operation: MANUAL and AUTOMATIC.

Everyone likes a little flutter. The recent introduction of so many outlets in competition for the gambling dollar is positive proof of this. Every week the total prize pool for these games rises and this alone must draw in many new customers.
The possibility of winning something for nothing lures even the most cautious person into buying a ticket.
Nothing has been more successful than LOTTO. The concept of choosing your own numbers is brilliant. It has fooled the greater percentage of punters into thinking they are closer to picking a winner by this method, than buying a pre-numbered ticket.
Although nothing could be further from the truth, no amount of explanation will deter the avid invester from his weekly punt.
So, rather than being against them, we have decided to join forces and produce our contribution to selecting a winning combination. . . we have called our electronic number predictor:
LOTTO NUMBER SELECTOR.

This is our cover project. It will almost certainly create a fortune for someone and provide lots of fun in construction and operation.
Our circuit is a real gem. It looks simple but lurking within the 5 chips are a number of interesting building blocks.
The most significant feature of the circuit is the absence of 14 display resistors. Both the 4511's are display drivers and under normal conditions, a set of dropper resistors would be required. We have designed our circuit to eliminate them.
At the other end of the electronics ladder we have used a single-pole switch with a centre off to provide 2 functions.
To achieve ths we have had to insert the switch in the negative line. All these features are fully explained in the following pages.
For now, lets look at some of the mis-conceptions of chance.

★ LOTTO or POOLS selector - to help you win a fortune!
★ Single or Dual dice for games such as Monopoly.
★ Percentile Dice for war games or other strategy games.
★ As a random number generator for pure amusement.

THE EFFECT

When the power switch is turned on (to either MANUAL or AUTOMATIC), the two displays will show two figure '8's'. These will gradually sbw down to a flicker and numbers will start to flick onto the displays. This will slow-down even further until double numbers can be identified. Finally, a random number will remain on the screen.

A BRIEF SUMMARY OF HOW THE CIRCUIT WORKS

When the switch is turned on, a Schmitt trigger oscillator supplies a 10kHz signal to a 4518 chip. This is a divide-by-ten counter with 2 separate stages. The output of these is in binary and these 4 lines of binary are fed to individual display drivers.
The numbers appearing on the two displays are randomly generated due to another slow cycling oscillator providing the halt condition. Between each number appearing on the screen, the high speed oscillator is generating up to 40 clock counts.

TWO-UP!

Take a simple penny (we will have to convert to a 20¢ coin for the younger readers however a penny has much more feeling and authenticity when it comes to gambling). A penny was used anywhere from a cricket field to the bar in a hotel for decision making. It provided answers to complex questions such as "who will shout next", "who bats first" or "who pays the taxi fare".
The chance of a coin landing heads is 50%. Thus it is obvious to everyone as being a fair way of solving a dispute.

A die or dice is also used in decision making and the chance of scoring a high number is one-in-six.

These are easy figures, However if I asked about the probability of selecting 6 numbers from a total of 40, most people would give an answer which would be so far from reality that they would be astonished.

Very few people understand high numbers. As proof, try a friend with this simple problem. Take a sheet of paper and tear it in half. Place the two halves on top of each other and tear the stack again. Repeat the operation 20 times. How high do you think the pile of paper will be? If I said it would reach the moon, would you be impressed? Such is the enormity of multiplication.

Because it seems so utterly impossible to create an enormous possibility with just 40 insignificant numbers, LOTTO has taken off from its very inception, and never looked back. Chance and probability is a fascinating mathematical study. One which can engrose a dedicated mathematics student for his entire life.
The pseudo study of probability has been the downfall of many a punter as everyone thinks he or she is a good predictor.
Without the correct mathematical data, the casual backing of 'hunches' or 'certs' will eventually bring the novice to bankruptcy.

It is only by using probability correctly that you will increase your winnings. However the gain rate is only 2 to 5 per cent and few people are happly with low margins. They want big wins and quickly!

Don't think I am encouraging this form of wager. Just because I have presented a Lotto Selector does not indicate my acceptance of gambling of any kind. And yet by stating that, I am a hypercrit. Life is a gamble. Running a business is a gamble. Even driving to work or buying a product is a gamble.
Gambling itself is not a danger. It is only the excess of gambling which leads to ruin.
So, away from the preaching.

If you are against any form of gambling, you can use the LOTTO project to play a number of harmless games.
The two readouts can be considered a dual dice, in which the numbers 1 to 6 are used and any other numbers are ignored.
Other games such as war games or MONOPOLY require percentile readout and both digits can be used.
On the other hand you can use it on a personal basis to guess the next number to appear. With the switch set to the automatic position, you can use the project as a guessing game.
This is even more dramatic in a darkened room where the display will give the best results. You can even use it as a sleep inducer and try to stay awake until the batteries run down!

HOW THE CIRCUIT WORKS

THE SCHMITT OSCILLATOR

The heart of the LOTTO SELECTOR is a free-running oscillator. This is made up of a Schmitt trigger between pins 13 and 12 of the 74c14. It oscillates at approximately 10kHz due to the value of the frequency-setting components: the 10n capacitor and 4k7 resistor.
The output of the oscillator has a very short duty cycle due to the presence of the 1N 914 diode. This means the ON time for the output is very short compared with the OFF time. The charging time for the 10n capacitor is provided by the diode and because it has a very small voltage drop, the capacitor is charged very quickly.
When the capacitor charges to ⅔ of the rail voltage, the trigger changes state and the output goes LOW. The diode is not reverse biased and does not have any effect on the discharge of the capacitor. The discharge time is provided by the 4k7 resisitor and these two components are the frequency-setting items. The discharge-time to charge-time is appproximately 25:1. This duty cycle will not affect the counting of the decade counter chip (4518) but is as essential part of a very clever design. More on this later.

The 10kHz signal is passed to the clock pin of one half of the 4518. This chip is a decade counter and will divide the incomming pulses by 10. It is designed to give a readout of the numbers 0 to 10 in binary form and this requires 4 output lines as shown in the diagram.
The highest priority line (pin 14) is then taken to the clock input of the second stage. The result is a counter capable of counting to 100.

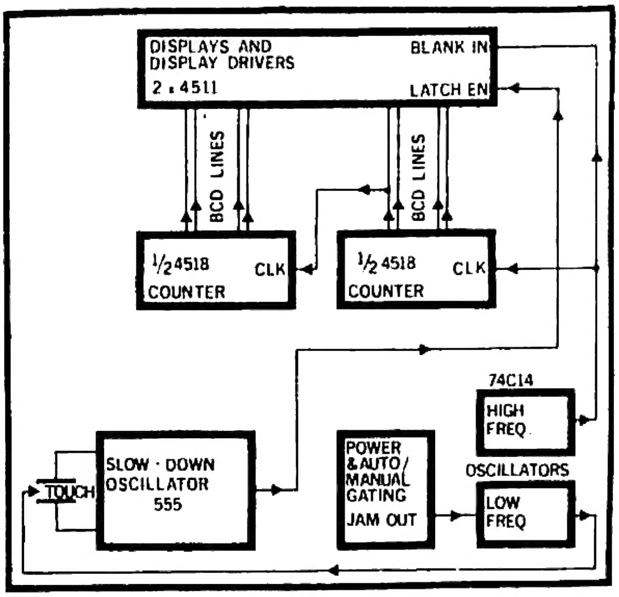
Each of the outputs consist of 4 lines of binary information of a decimal number. Thus it is called BINARY CODED DECIMAL.
These outputs are passed to a 4511 display driver chip which is designed to convert the binary information to 7 lines of information to drive a 7-segment display. One chip is fully employed doing this because of the number of pins required.
Another feature of the 4511 is the LATCH or FREEZE capability.
A number can be frozen on the display while another is being set-up on the input lines.
Two pins control this effect.
One pin (pin 4) is called the BLANKING INPUT pin. It has the effect of turning off all the segments when it is LOW. This means it is ACTIVE LOW. (It produces an effect when it is LOW).
The other pin (pin 5) is the LATCH ENABLE pin. It produces the freeze effect when it is HIGH because it enables the latch (opens the latch) when it is LOW.
This is what happens: If pin 4 is LOW, you will not be able to see anything on the display at all. When it is HIGH, the figure on the display will depend on the values of the incomming BCD lines and also the state of the LATCH ENABLE pin number 5.

. . .HOW THE CIRCUIT WORKS

If pin 5 is LOW, the numbers will change on the display according to the change in the incomming information. When it is HIGH, the display will freeze and the incomming information will not get through the latch circuit.

Now imagine the blanking pin being turned on for 4% of a cycle and off for 96%. This is occuring at 10,000 times a second, when the LOTTO project is switched on. Because the speed of this flashing is too fast for us to see, we think the display is on all the time. But electronics is faster than the eye. The display (made up of 7 light emitting diodes) will respond to this speed and they will turn on and off without being damaged.

The reason for this clever circuit arrangement is very interesting. You will notice we have not included any display dropping resistors between the display and the driver chip. Normally we would require 7 resistors of about 470 ohm for voltage dropping to each display. And this circuit would need 14 resistors. We have eliminated them entirely.
How clever! This has saved parts, space and layout problems. The reason for choosing this method of operation is two-fold. We avoid the wasted power produced by display droppers and secondly, the display is allowed to operate at a more efficient level.



To achieve a good level of brightness, it is possible to drive the displays with 4 times the normal current for a very short period of time. This produces a bright display because the light emitting crystals have a higher efficiency at higher currents.

The next feature to look at is the number changing circuit.

This is accomplished by briefly bringing pin 5 LOW, then HIGH again. The new number appearing on the BCD lines will be frozen by the latches and displayed on the FND 500's. A 555 is used for the number changing operation because it can be designed in a circuit to have a very short pulse width, can be made to slow-down and is guaranteed to go LOW at the completion of its cycle.

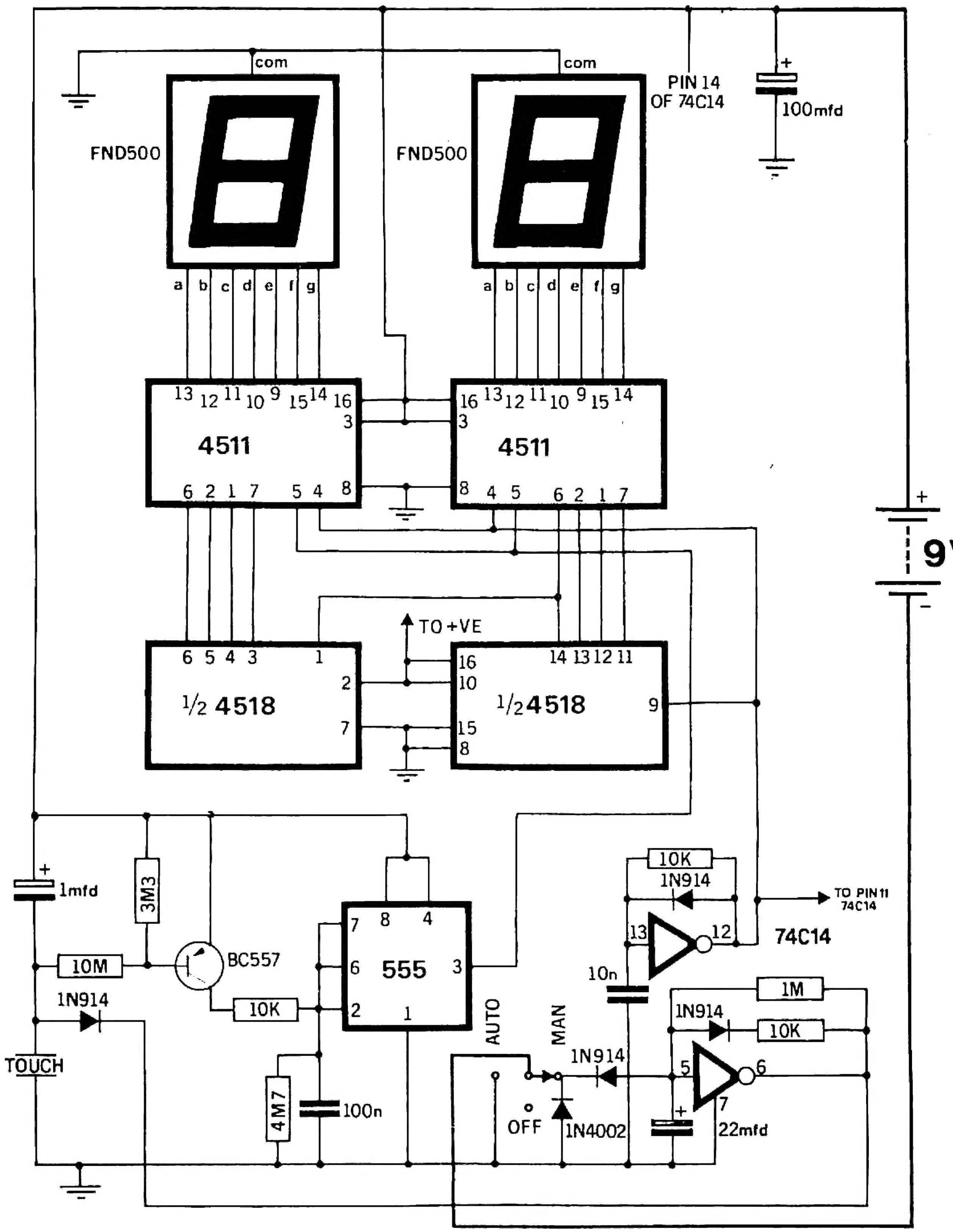
The slow-down operation is accomplished by a BC 557 transistor. This transistor is being turned on by the charge (voltage) on a 1mfd electrolytic and the transistor is acting as a variable resistor. The transistor and 10k make up the charging resistance for the 100n capacitor. The discharging resistor has been eliminated and this means the LOW time for the cycle will be very short.

To start the slow-down oscillator functioning, the 1mfd electrolytic is charged slightly when you place your finger on the TOUCH WIRES. This voltage is passed to the base of the BC 557 transitor via the 10M resistor and a 'turn-on' condition occurs between base and emitter. The 3M3 resistor is a bleed resistor to slowly discharge the 1mfd electrolytic.This causes the 'effective resistance' between the emitter and collector to change and the 555 responds by changing its clock rate. The 4M7 across the 100n timing capacitor ensures the voltage on the 100n decays to zero and prevents the 555 from giving out random clock pulses once it has stopped.

The circuit is designed for AUTO or MANUAL operation.
In the manual position, the touch switch comes into operation and you can throw your own numbers by touching the TOUCH SWITCH.

In the AUTOMATIC position, The LOTTO SELECTOR will dial up a number, display it for a few seconds, then start counting again. This automatic control is governed by a long time delay created by the Schmitt Trigger between pins 5 and 6. Its repetition rate is controlled by the 1M resistor and 22mfd electrolytic Normally the output of the trigger inverter is HIGH. This causes the 22mfd electrolytic to charge up via the 1M resistor to ⅔ rail voltage. The trigger circuit changes state and the output goes LOW. When this happens, the 1mfd electrolytic in the slow-down circuit is charging up via the diode and this has the same effect as touching the TOUCH WIRES.
The 22mfd electrolytic discharges via the 1N 914 diode and the 10k resistor fairly quickly and this gives a brief pulse on the 1mfd electrolytic. When the voltage on the 22mfd electrolytic falls to ⅓ of the rail voltage, the output of the trigger inverter goes HIGH. The slow-down circuit comes into operation to give you a new number. This repeats itself ad infinitum.

Lastly a clever trick with the on-off switch.
So that the long delay timer does not come into operation when the Selector is set to Manual, we have held the voltage on pin 5 LOW via a diode. It may not be easy to see, but the 1N 4002 is positioned so that it supplies the rest of the circuit with power when switched to the MANUAL position. In this setting, the 1N 914 diode is connected to earth and pin 5 cannot rise more than .5v, thus the trigger circuit will not cycle. This arrangement could not be done in the positive line as the Schmitt trigger must be held LOW for its output to remain HIGH.



The compl'ete LOTTO circuit. The schematic diagram closely follows the layout on the PC board.
Remember: The 4518 is shown in two halves on the diagram.

ASSEMBLY

All the components fit on the top side of the printed circuit board and each part is identified on the overlay. Your task is to learn about identifying the parts while constructing the project. So take your time.

Lay the components on the work-bench and make sure all the parts are present by referring to the parts list. Place the resistors around one way and grade them into ascending order. Don't make a mistake between the 1M and 10M. Check the difference between blue and green.

The first items to fit onto the board are the jumper links. These are made from tinned copper wire which has be straightened to remove any kinks. Start at one end of the board. Cut a length of wire and bend it into the form of a staple or 'U' shape. Fit it through the holes in the board and solder each end with a hot soldering iron. When soldering is completed, the jumper link should be touching the board and the wire should be straight. Complete the 12 links and two TOUCH WIRES with the same type of tinned copper wire.

Next components to mount are the diodes. These are sometimes hard to identify and an important point to note is the COLOUR of the band or bands is NOT the major identification. It is either the thickness of one of the end bands or its position at the end of the diode.

Take these examples:

A diode with a blue painted band indicates the cathode. Do not take any notice of the red lead inside the glass bead. This is purely the colour of the terminating cup for the crystal.

A diode with a thin brown line, a thin yellow line, a thin red line and a thick yellow line is identified by the thick yellow line being the cathode.

The 8 resistors are the next components to fit onto the board. The leads should be bent close to the end of the resistor but not so sharply that the lead is likely to break off. Insert the resistor until it touches the PC board. You should be able to hold your fingers on the resistor while you tack one end with the soldering iron. The other end can then be soldered and the first end re-soldered to create a perfect connection. Double-check the value of each resistor before going on to the next to make sure a mistake has not been made.

PARTS LIST

3 - 10k
1 - 1M
1 - 3M3
1 - 4M7
1 - 10M

1 - 10n 100v greencap
1 - 100n 100v

1 - 1mfd 16v PC electro
1 - 22mfd 16v electro
1 - 100mfd 16v electro

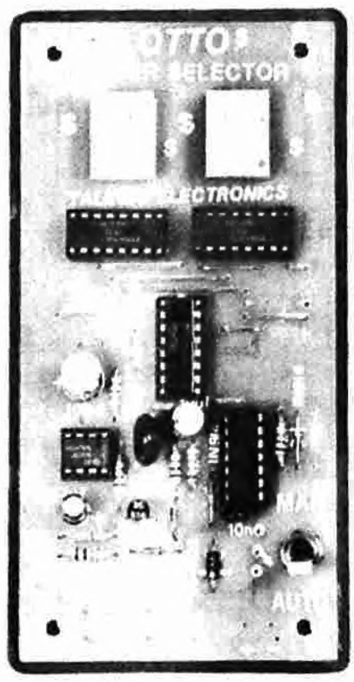
1 - BC 557 transistor

4 - 1N 914 diodes
1 - 1N 4002 diode

1 - 555 timer IC
1 - 74c14 (40014) IC
1 - 4518 dual BCD counter IC
2 - 4511 display driver IC's
2 - FND 500 displays
1 - 8 pin IC socket
1 - 14 pin IC socket
3 - 16 pin IC sockets

1 - ON-OFF-ON switch
1 - battery snap
tinned copper wire

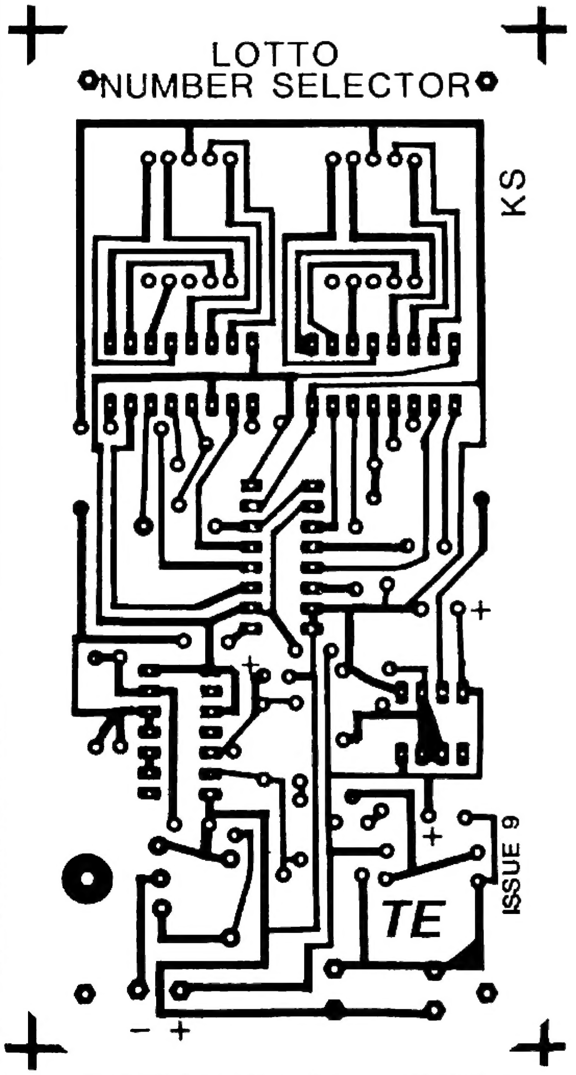
LOTTO PC BOARD



Complete LOTTO fits onto Zippy box.

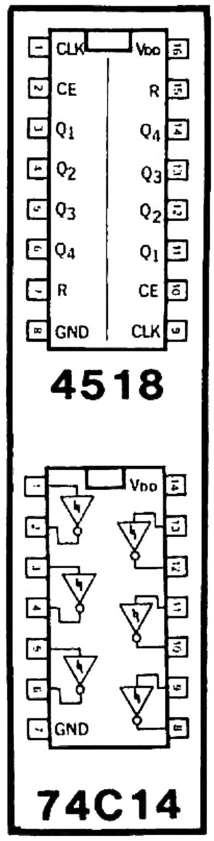
Fit the 5 IC sockets so that the pin 1 identification on the sockets covers the dot on the PC board. This will make it easier to insert the chips around the correct way at the completion of the project. Solder each pin cleanly and swiftly, amking sure the lands do not bridge with solder.
The two FND 500 displays are identified by the decimal point and these are soldered in position as shown in the photograph.
The 1N 4002 power diode is mounted so that the line on the diode case corresponds to the cathode lead on the overlay.
The 3 electrolytics are fitted so that the positive lead (the longest lead) fits down the marked hole. Take care when doing this because the marked lead on the case of the electrolytic is the negative lead.
The two greencap capacitors can be fitted around either way and are soldered in position so that they touch the board.
The BC 557 transistor fits directly into the 3 holes on the PC board.
Connect the ON-OFF-ON power switch through the hole in the PC board and use tinned copper wire to connect the 3 leads to the board.
A battery snap finishes the construction of the project.
All that is left to do is fit the 5 chips into their sockets with pin 1 covering the dot on the PC board.
The LOTTO SELECTOR is now ready for run-up.

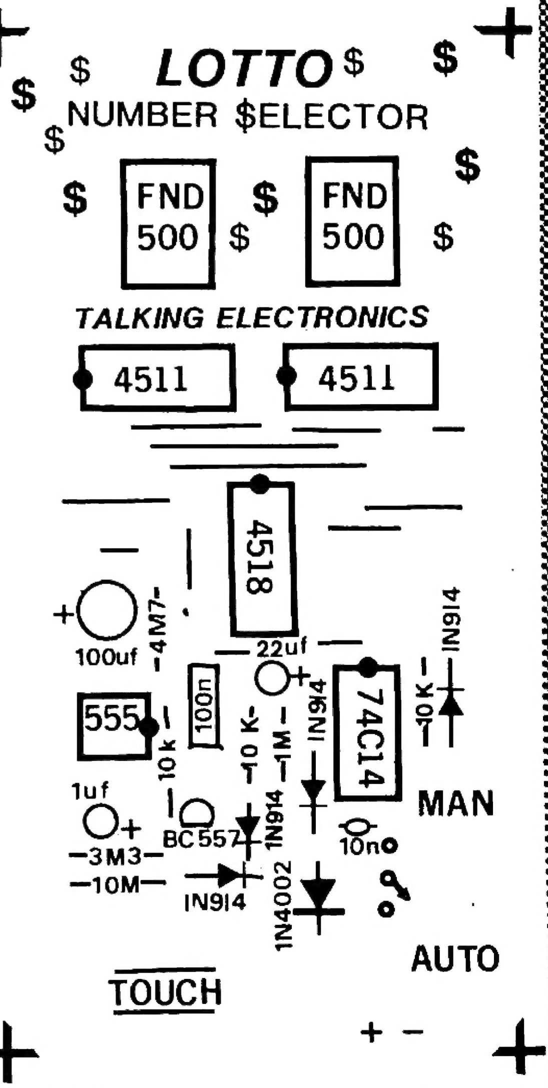
A 9v transistor battery or 6 penlite cells in a holder is recommended for the first trial run. Nicads can deliver a very high current and may cause damage if a short circuit is present.
After the selector is found to be working properly, a set of nicads can be used as the power source.



LOTTO PC PATTERN

PIN OUTS





OVERLAY WITH PARTS IDENTIFICATION

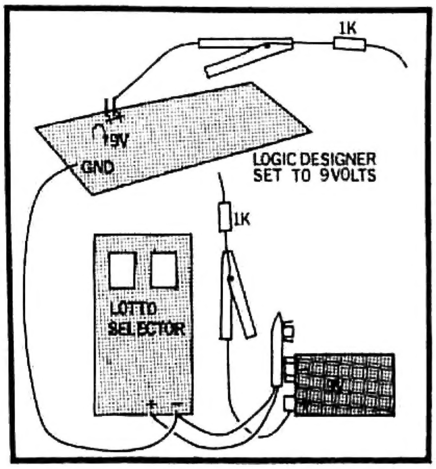
IF IT DOESN'T WORK:

If the LOTTO SELECTOR doesn't work, you will need a mulitmeter and the LOGIC DESIGNER to get into the signal side of the circuit.

The illumination of the displays will be the deciding factor on where to look.

IF THE DISPLAYS DO NOT LIGHT UP

Connect the negative terminal of the battery to the project and use a jumper lead connected to the positive terminal as a test lead. Place a 1k resistor in line with this test lead and switch the project on to MAN or AUTO. The Lotto project will not be powered by the battery for this test and, in fact, the circuit must not be operating for this part of the test as the outputs of the 4511 will short-out our test-voltage.



Touch the 1k resistor along the top row of pins for each of the 4511's (pins 9 to 16 and you will see each segment of the display light up in turn. If they do not light up, either the displays are faulty or the common earth lead is not connected to ground. You can also try these pins when the 4511's are removed. If the displays only light up when the chips are removed, the 4511's may be faulty or damaged.

If the displays check out ok with the 1k test resistor, but still fail to light, the fault may come from the BLANKING line. This is pin 4 of the 4511's. If this line is held LOW, the displays will not light.
You must be very careful when checking pin 4. You cannot let pin 4 float nor can you put a HIGH on pin 4 because the displays are directly coupled to the driver chips and may burn out if full rail voltage is applied to them. Pin 4 is normally receiving a very short pulse and only this short duty cycle can be duplicated for the correct operation of the set. A CRO will show you the mark-space ratio of the incomming pulse but in the absence of this piece of test gear you can use the Logic Designer as described elsewhere in this article.

A failure of the Schmitt trigger oscillator between pins 13 and 12 of the 74c14 will cause the displays to remain unlit if pin 12 is LOW or if pin 13 is HIGH. Pin 13 may be touching pin 14 or receiving a leakage from the 9v rail. The 10k resistor may be faulty and failing to discharge the 10n capacitor. The Schmitt inverter may be damaged. If this is the case, you can use one of the unused inverters in the package.

IF THE DISPLAY LIGHTS UP LIKE A CANDLE:

If the displays light up far too brightly, the fault lies in the high frequency oscillator betweeen pins 13 and 12 of the 74c14. Turn the Lotto Selector off immediately and add a 100 ohm resistor in one line of the battery. You can now trace through and find the fault without burning out the displays. Use the Logic Designer to detect the frequency of this oscillator by connecting to either pins 8, 9 or 10. You will NOT be able to detect the pulse on the output of the oscillator (pin 12), so use the buffer stages provided. The displays wil light up if the oscillator is jammed in the HIGH output mode. This means the input (pin 13) will be LOW and this could be due to a short in the 10n capacitor, a short between the leads or a leakage path to earth. It could also be the chip itself. Another possibility is the failure of both the 10k resistor and diode. This will result in the 10n capacitor failing to charge up.

Many of these possibilities are highly unlikely but it could be a fault in the soldering of the 10k resistor and diode which has left the charging line open. These things do happen. We have found hairline cracks in the PC linework, fine hairs of solder touching adjacent tracks and hard-to-detect dry joints. So don't be surprised if you find the trouble turns out be microscopic!

IF THE NUMBERS DON'T CHANGE

The numbers on the display change when the LATCH ENABLE pin 5 is LOW. The pulses from the 4518 can now pass through the display driver chip (4511) and alter the numbers. A HIGH on pin 5 will freeze the numbers. Both LATCH ENABLE pins are driven from the output of the 555 and the fault could lie within this oscillator. Test the operation of the 555 by placing a 100k resistor on jumper leads and connect one to the positive of the battery. Touch the other onto pin 7 of the 555. You should see the numbers change fairly rapidly. A 1M resistor will make the numbers change at a slower rate. If the numbers do not change, the fault will lie in the 100n capacitor being open (dry joint) or the 4M7 is the wrong value (take it out for this test). Pins 2 6 and 7 have a leakage path to earth or are touching earth. The 10k resistor is the wrong value or is touching earth. If the 1M resistor produces a change in the numbers on the display, try both ends of the 10k resistor: the effect should be the same. If not, the 10k could be open.
Next place a 1M resistor between the base of the BC 557 transistor and earth. This will turn the transistor on. If nothing happens, the transistor will be faulty. Try another PNP transistor. Make sure it is a PNP type!
Finally try both ends of the 10M resistor with a 100k resistor on jumper leads. If the TOUCH SWITCH side of the 10M resistor does not work, it may be an open resistor, the 1mfd electrolytic may be shorted to the positive line of the 1N 914 diode may be reversed or shorted.

IF THE DISPLAY DOESN'T STOP

If the display keeps ticking over and does not finally come to rest in the MANual position, it may be due to leakage in the BC 557 transistor, leakage across the TOUCH lines, or leakage in the 1N 914 diode. Remove the diode, lift one end of the 10M resistor, lift one end of the 3M3 resistor. If the ticking still occurs, the transistor will be leaky. Another possible fault is the 100n capacitor not fully discharging. The 4M7 is designed to carry out this operation. Try a 1M resistor across the 100n capacitor. Pins 2, 6 and 7 may have a leakage path to positive rail. Check your soldering and track work.
If the display doesn't stop in the AUTO mode, the fault will be due to the time delay circuit made up of the inverter between pins 5 and 6, the 22mfd electrolytic and the 1M resistor. You can use a multimeter to see when the output pin (6) is HIGH. It should remain HIGH to allow the numbers to gradually slow down. If it goes LOW, the numbers will speed up again.
To lengthen the time delay, the 1M resistor can be increased. But firstly try another 22mfd electrolytic as these electros require a "forming" voltage on them to produce their full capacitance. After a few charge-ups, the capacitance increases.
To increase the time delay, use a 1M5 resistor as the charging resistance. If the display keeps cycling in the MANual mode, the gating diode on pin 5 of the inverter will be open or have a dry joint. If the display does not cycle and produce a new number in the AUTO mode, the delay timer is not operating. Check the output pin 6 with a multimeter for a change from HIGH to LOW after 10 or 20 seconds. If this does not occur, the timer is not operating. The fault may be due to leakage within the 22mfd being higher than the charging current and consequently it never reaches its ⅔ Vcc value. The 1M resistor may be the wrong value (say 10M), the 1N 4002 diode may be leaky (remove it and see if the problem is cured) or the chip itself may be faulty.

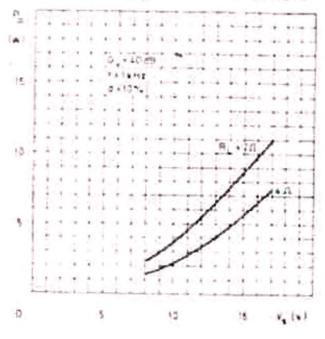
I hope you don't have any insurmountable problems with the LOTTO project but it would be nice to have a small problem and need to use either a multimeter or the LOGIC DESIGNER to locate the fault.

8 WATT POWER AMP

$8.30 COMPLETE

The 8 watt amplifier was developed after a number of requests were received from readers who wanted to build the SIMPLICITY AMPLIFIER but thought it would be a little low in power for their application. More often it came from hobbyists who thought 3 or 4 watts per channel was a little 'light-on' and wanted something more powerful. Mind you, they hadn't built the Simplicity Amp!

Until you feel the effect of 4 watts, you can hardly say it is insufficient. By comparison, a TV set is supplying about ½ watt under normal listening level about 2 watts whan turned up loudly. Wattage and sound level are hard values to comprehend. Sound pressure level is a logrithmic value meaning that to double the loudness of a sound you need to supply 10 times more power.
So, an 8 watt amplifier will not be twice as loud as a 4 watt amplifier. It will only be marginally louder. As with the simplicity amp, the power output of this amplifier depends heavily on the applied voltage. Most of the power output figures for power amplifiers apply to the maximum voltage allowed and this chip is no exception.
The graph shows the relationship between power out and applied voltage. Notice how the 8 watts only applies to a 2 ohm speaker and results when the applied voltage is about 15v.



For a 4 ohm speaker the power is practically halved. This feature has its good side. It means that you can parallel two 8 ohm speakers or four 8 ohm speakers or two 4ohm speakers and still get the same power or loudness emerging from each speaker. To test our prototype, we placed four 8 ohm speakers in parallel to make a cube. The volume was quite sufficient to blast the workers in the assembly room and the volume control was only about half. The clarity and bass response was exceptional. The figure given in the technical specifications for distortion up to 5 watts is .2%. In fact the amplifier has very good figures up to 6 watts with a 2 ohm speaker and 4 watts with a 4 ohm speaker. Once these limits are reached, the distortion level increases rapidly to 10% and at this level the average person can noticeably hear that 'something is wrong'.

This 8 watt amplifier uses a single 5 pin chip which looks like a TIP transistor. The whole circuit design is so simple and compact that the amplifier fits onto a PC board 4 cm x 9 cm.
A circuit board is needed for this project as it is extremely important to produce an earth line without a HUM loop. This has been achieved by making a cut in the track on the negative line where the common enters pin 3 of the amplifier. This produces a pinch point where the current must flow past pin 3 and not form circulating currents. The layout of the PC board also fixes the stray capacitance of the components as well as the actual inter-wiring capacitances. The positioning of the components is important to keeping background hum to a minimum. All this has been studied and adjusted before laying out the finished board. You reap the benefit of many hours of design and construction by using this PC layout.

The 8 watt amplifier chip used in this circuit is made by at least two different manufacturers and thus it has two different part numbers: TDA 2002 and LM 383. They are both identical to each other.

PARTS LIST

1 - 1R
1 - 2R2
1 - 39R
1 - 220R

1 - 39n
2 - 100n

1 - 4u7
1 - 470mfd
2 - 1000mfd

1 - mini 'U' heat fin
1 - nut and bolt to suit
1 - heat sink compound

1 - LM 383 or TDA 2002 IC

1 - 8 watt POWER AMP PC board

HOW THE CIRCUIT WORKS

The circuit uses an LM 383 power amplifier coupled to a low impedance speaker. This chip is designed to drive low impedance loads and will operate most effectively when driving a 2 ohm or 4 ohm speaker. The external components required for the power amplifier are either for feedback, decoupling or high frequency suppression.

The amplifier itself is of a highly stable design with an enormous open loop gain. The amplification of this module is something like 10 million and with the heavy negative feedback, the gain is reduced to about 10,000 times. A power gain of this magnitude is needed to supply 8 watts from an input of only 10 to 50 millivolts.

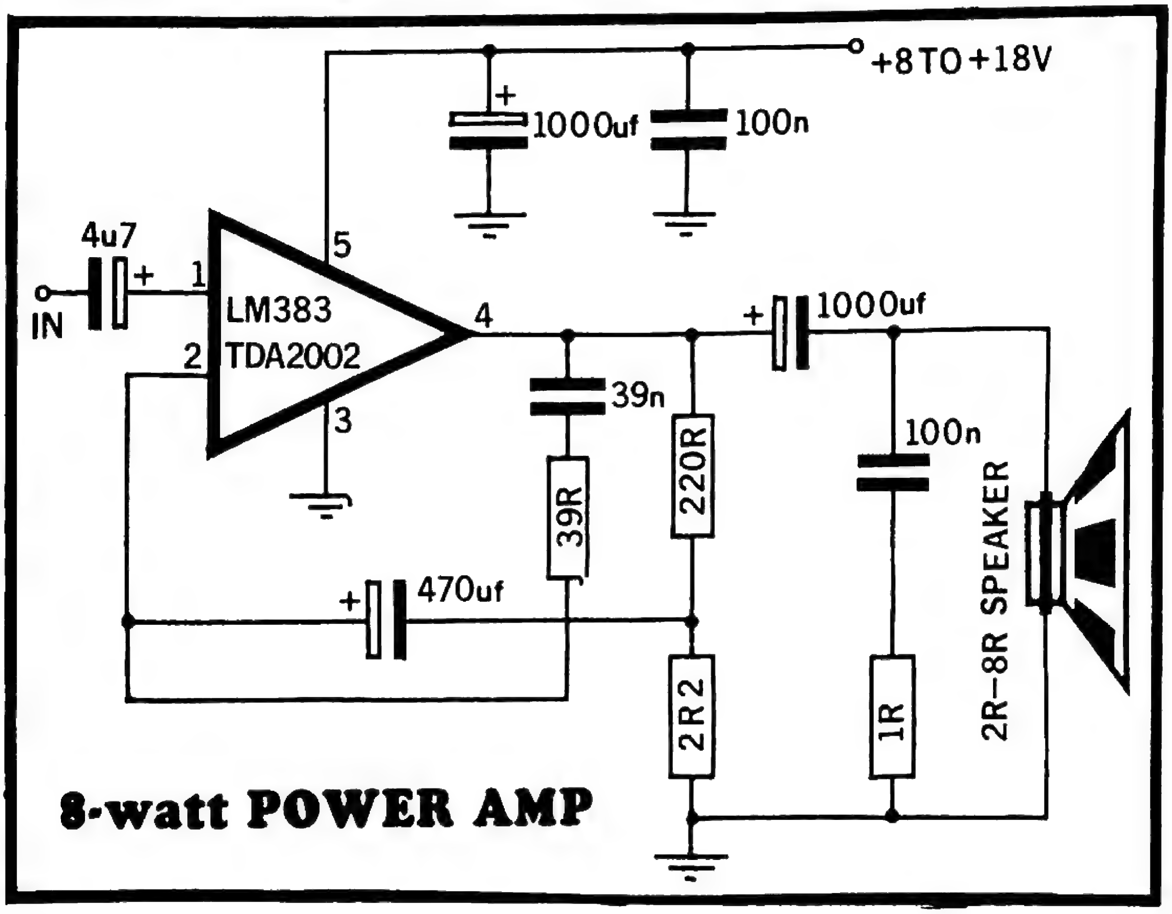
The function of each part is as follows:

The 4.7mfd electrolytic at the input is designed to AC couple the amplifier to a source such as a tuner or crystal cartridge.

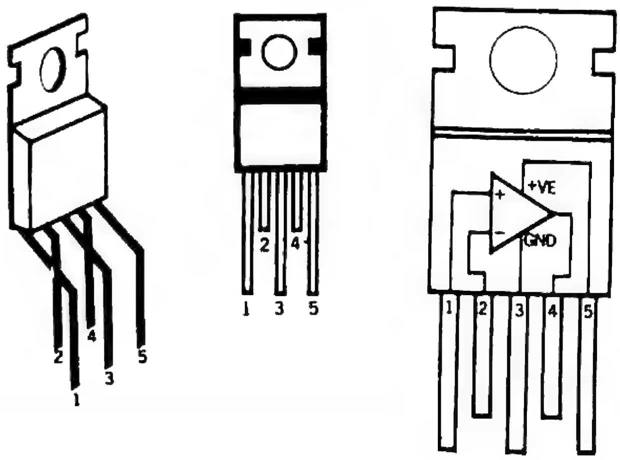
The circuitry inside the chip is wholly DC coupled and this means the DC level at the input pin must not be shifted. The 4,7mfd input capacitor allows the circuit to operate without and DC shift occuring. A volume control can be added to the input and must be placed before the capacitor.

The power rail has a 1,000mfd electrolytic and 100n capacitor across it. The 1,000mfd is a storage capacitor for supplying high currents during peak passages and it also has some effect on reducing the power supply ripple. The 100n capacitor is quite important to prevent a form of oscillation from occuring at critical power supply impedance levels.

The 39n and 39 ohm resistor form the negative feedback network. The value of C is designed to set the upper frequency cut-off and a larger value of 39n will reduce this maximum frequency. The 39 ohm resistor also sets the high frequency cut off point and if reduced in value, oscillation may occur.

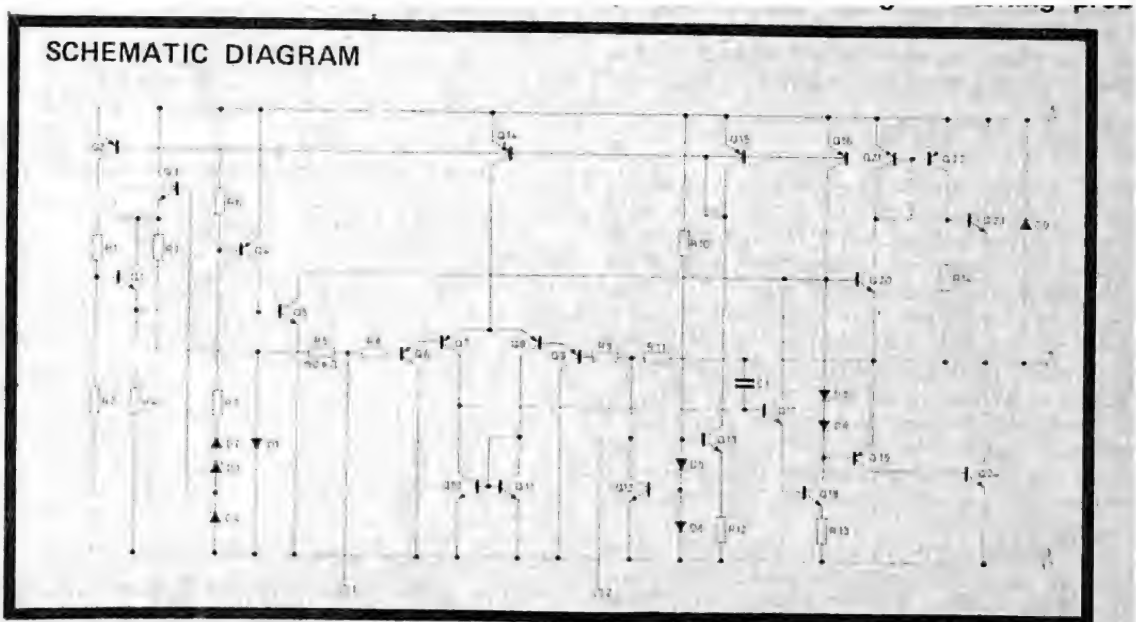


8-watt POWER AMP



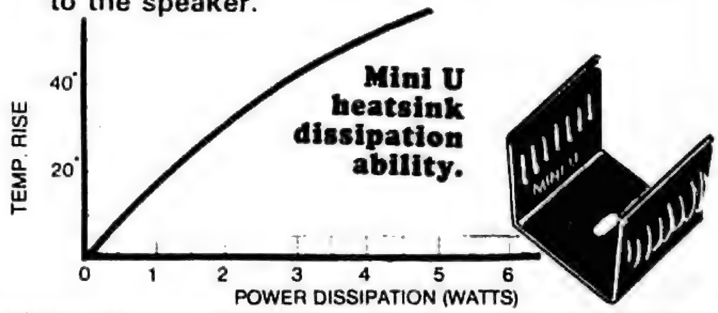
HOW THE CIRCUIT WORKS

The actual gain of the amplifier is set by the ratio of the 220 ohm resistor and 2R2 resistor. This working point is AC coupled to the inverting input via a 470 mfd electrolytic which is classified as 'tight coupling' and yet does not alter the DC condition on the input.
The remaining 3 components are in the output line and across the speaker.
The 1,000mfd electrolytic provides coupling to the speaker. Its value must be high to allow the bass notes to be heard. These notes give a richness and clearness to an amplifier and explaines what a high power amplifier is really all about. If you can operate a high power amplifier at low volume, the clarity and low frequency response is extremely good. This is the main reason for introducing high power audio amplifiers.
The speaker cannot be directly coupled to the output as pin 4 is at mid rail voltage as determined by the push-pull output transistors.



Connecting the speaker to this point would reduce the voltage appreciably. So the electrolytic serves to separate the two points AC-WISE. In addition, the speaker must not have any DC component passing through the voice coil as this would 'off-set' the cone and produce a distorted sound. The electrolytic blocks the DC component from the output pin.
The 100n capacitor and 1 ohm resistor prevent high frequency oscillation from occuring. At high frequencies the speaker is seen as an inductive load to the signal and a dampening network provided by the 100n and 1 ohm is needed.
The amplifier module includes a number of important features which are needed to prevent the chip from being destroyed. The most important of these is thermal shut-down. If the chip gets too hot, an inbuilt temperature sensing stage almost completely shuts the device down when the temperature reaches 150° C. This means the heatsink can be slightly smaller than normal without running the risk of damaging the chip. The same circuit senses temperature rise due to overload on the output, or a short circuit on the output. This is a very handy feature for the occassions when you are experimenting. Surprisingly enough, the speaker leads can become shorted together and luckily no damage will occur. In years gone by, this would result in the amplifier being instantly destroyed.!

The schematic diagram for the circuitry inside the chip shows 24 transistors. The main reason for the high number of transistors is the DC coupling throughout the amplifier. It is very difficult to fabricate capacitors on a chip and the only alternative it to connect each stage directly to the next. But this produces a lot of impedance and voltage matching problems, requiring transistors in extended chains. The output is class B and the amplifier has the relatively high efficiency of 60% to 70%. This means for an output power of 8 watts into the load (speaker), you will need to dissipate about 5 watts from the amplifier to the heatsink. This 8 watts and 5 watts is only a peak value and would apply to a very loud passage of music. Normally about 2 to 3 watts will be lost from the chip and about 4 to 5 watts will be passed to the speaker.



HEATSINKING

Heatsinking is one of the most important considerations when making this amplifier. If you don't heatsink the chip perfectly, you will be wasting your time trying to get full power out of it.
The heatsink we have chosen is a MINI 'U'. It has the capability of dissipating about 4 watts without overheating the chip. But the most important factor for the dissipation to be effective, is the contact between heatsink and metal case of the power amp chip.
You will find the mounting surface of the heatsink will be irregular and you will have to produce a perfectly flat surface to gain intimate contact with the metal of the chip. To do this you will ned a flat file. Draw the heatsink over the file and note the areas being removed. You may need to bend the heatsink slightly to gain access to the centre section near the hole. Produce a flat surface the same size as the area of the chip. Place the two together and look for the light between the gap. If this is a minimum, you can smear a little heatsink compound on the heatsink and slide the chip into position so that the compound is as thin as possible. Now fit the two together with a nut and bolt.

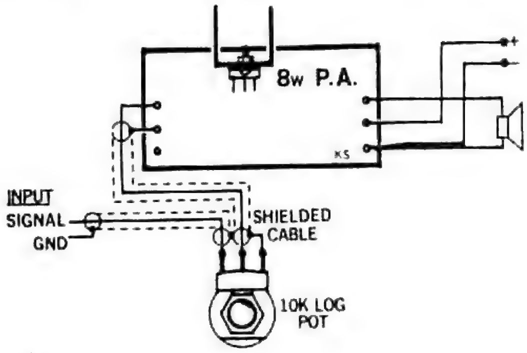
CONSTRUCTION

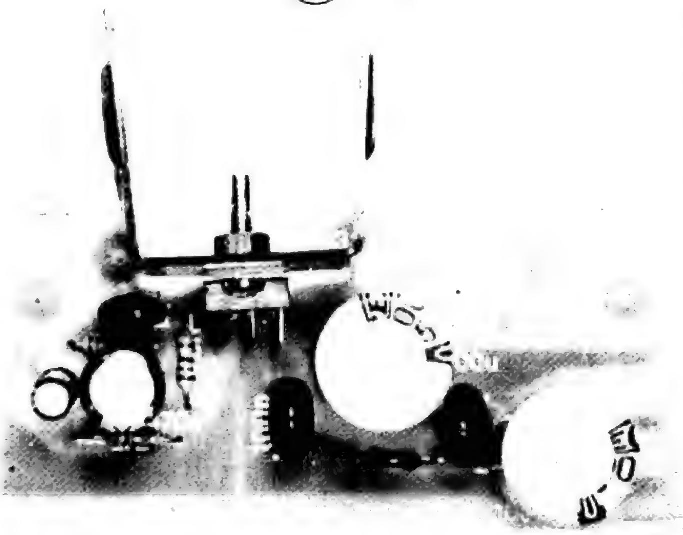
The printed circuit board includes an overlay showing the positioning of all the components. It is only necessary to correctly identify the resistors and place the electrolytics around the correct way. Start with the 4 resistors. These are fitted so that they touch the board. This neatness is important. Near the 470mfd electrolytic the components are very close together and the electro fits over the resistors. The positive lead of each electrolytic is identified on the board however the negative lead is marked on the component. Take care when fitting.
The 3 greencaps can be soldered either way around and must touch the board to give a professional look about the project.
The last component to fit is the amplifier chip. You should already have the heatsink attached. Bend the 5 leads of the chip as shown in the diagram so that it will solder straight onto the board. The tab of the chip is not connected to any of the pins and this means no insulating washer is needed. The strength of the 5 pins will be sufficient to support the heatsink provided the amplifier is not going to be shifted or vibrated. Mounting the heat fin perpendicular (up and down) will allow the hot air to pass the flanges and dissipate the maximum amount of heat.

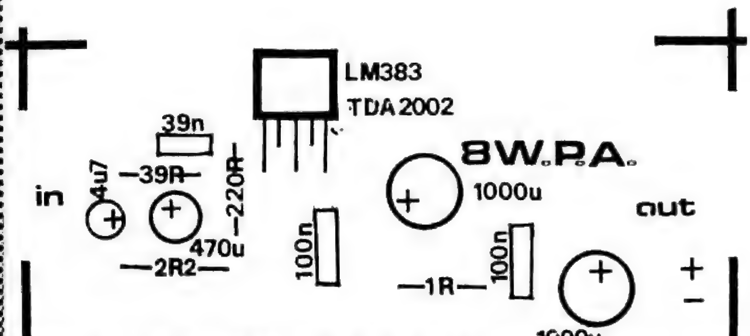
CONNECTING UP THE AMPLIFIER MODULE

The amplifier module has 4 large holes which can be used for mounting purposes.
When considerng a case for the amplifier, it is important to allow sufficient room for a power supply, another module for stereo, a pre-amp PC board as presented in issue number 7 and plenty of space for ventilation.
The heatsinks can be attached to the case for rigidity if required and they do not need insulating as the amplifier tabs are not connected to the circuit. The input line can be connected directly to a ceramic cartridge via a volume control and the amplifier will operate to its full output power with the volume control nearly wound fully up.

Power for the project can be obtained from a power supply similar to the supply described in issue 3 page 4. This is a 1 amp supply and has a 12v output range. This can be increased to 15v by increasing the value of R3 from 270 ohm to 470 ohm.





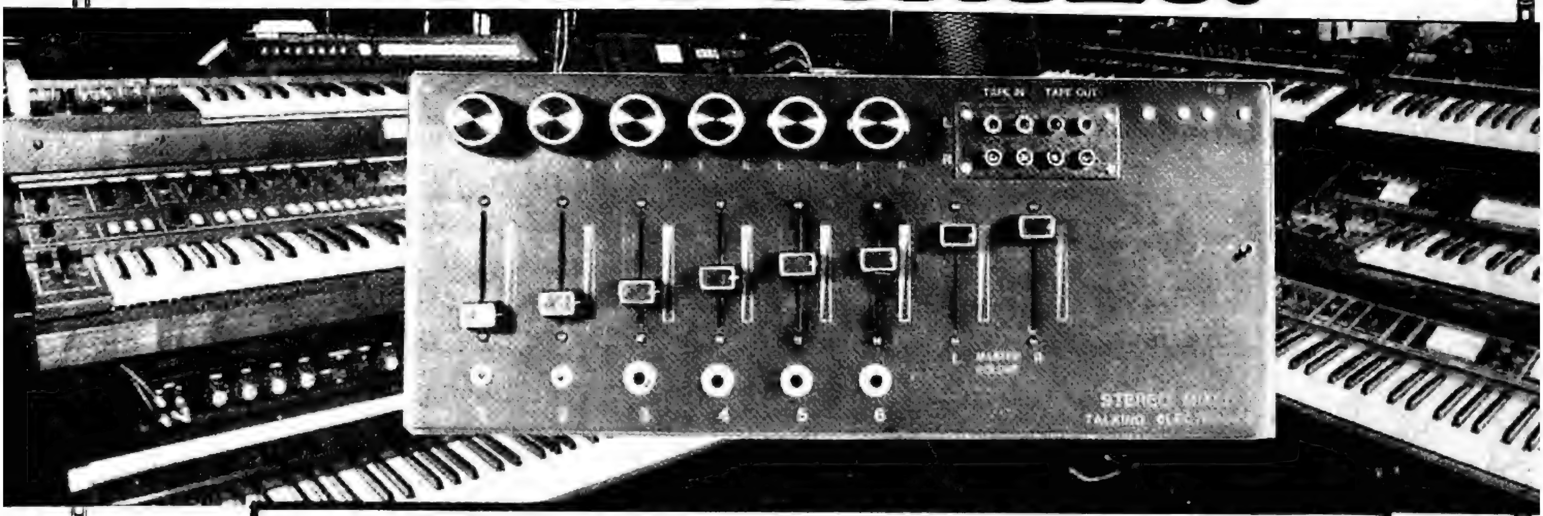


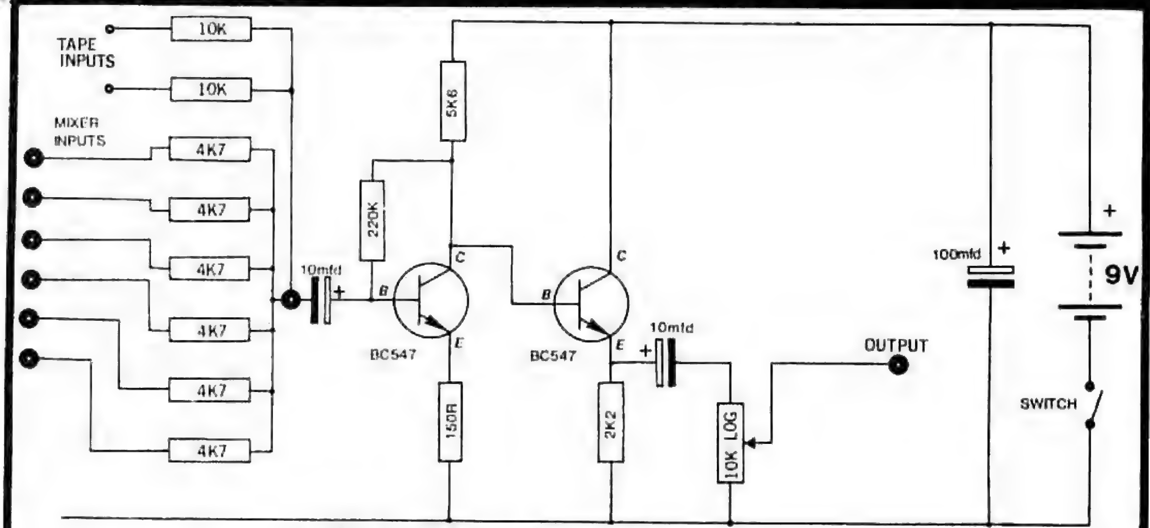
PC LAYOUT IS ON P 75.

The choice of speakers has been left to you. The most important consideration is to keep the voice coil impedance low. This can be done by connecting a number of speakers in parallel.
The hardware items and plugs for the input and output are available from most electronics shops. See the TALK-TRONICS catalogue for the RCA plugs and sockets.
You can make a stereo version by merely duplicating the amplifier.
We will follow up next issue with the connection of a pre-amp stage, so keep the size of the case large enough for an additional board.

STEREO MINI-MIXER

about $30 COMPLETE equal to a $150 unit.





CIRCUIT OF ONE MIXER

The mini Mixer published in issue 6 is great for live work but when it comes to studio recording, a stereo mixer is more suitable.
Our first version offered 4 inputs, each input having a separate volume control. The Mini Mixer PC board is designed to take up to 6 inputs and this makes it even more versatile than the first project.

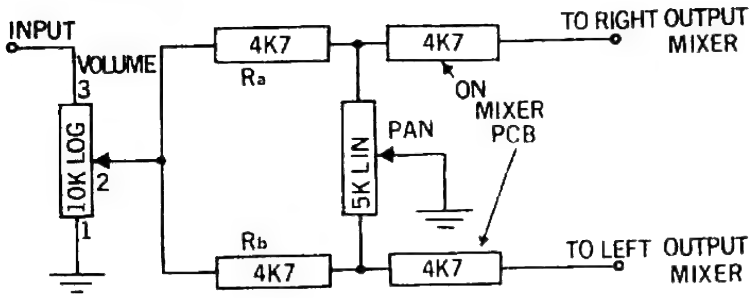
By simply using one Mini Mixer as the left channel and one for the right channel, a stereo output can be achieved with mono inputs.
By having 6 inputs you can have a selection of different size jacks (3,5mm and 6.5mm) to suit a range of patch cords.
The pseudo stereo effect is generated by the PAN control and this circuit is shown on the next page. The 5k pot is acting as a balance control with two 4k7 resistors on either side of the control acting as impedance setting values to keep the impedance of the system constant for any setting of the PAN control.

The Stereo Mini Mixer will also mix full stereo signals if you take the left signal into input number 1 and the right signal into input number 2. The PAN control of the first input is turned to the left and the PAN of the second channel turned to the right.
The second stereo signal is fed into inputs number 3 and 4 and the PAN controls correctly adjusted. Keeping the master controls towards the top, (these control the overall volume of the output), adjust the volume sliders for channels 1 to 4 to achieve the desired mix.
It is possible to cross the stereo signals from one side to the other by fully rotating the PAN controls for channels 1 and 2 or 3 and 4. This will cause the stereo signal to blend into a mono signal in the centre of the spectrum and then split into a reverse stereo image.

Additional tape signals can be blended into the mix by feeding signals into the tape inputs. Since there is no PAN or volume control

provided for these signals, they should be pre-mixed and the input volume adjusted at the output of the tape unit.

Power consumption of the unit is very small at 3 to 5 mA however it is best to turn the unit off when not in use.
The output from the mixer is taken from the RCA jacks. RCA jacks were chosen so as to be compatible with the line jack of most tape decks. A standard stereo RCA - RCA cord can then be used.



INPUT CIRCUIT - ONE USED FOR EACH INPUT CHANNEL REQUIRED

CONSTRUCTION

The stereo Mini Mixer is constructed on an aluminium panel 18cm x 42 cm. The screen printing artwork for this panel is shown in the diagram below and this does not show the cut-outs for the slde pots of holes for the rotary pots. A slot is required for each volume control and these are positioned 1cm to the left of the volume scale. The input jacks are positioned 1.5cm above the channel numbers. The PAN pots fit mid-way between the L R symbol and the edge of the board. The location of the power switch is obvious.

The Mixer PC boards are mounted on the underside of the panel between the RCA jacks and the end of the panel.

The wiring of the project is really very simple. Most of the circuit is on the printed circuit boards. These boards should be completely assembled before mounting. They should also have 9 or 11 connecting wires sodered to the lands and these leads should be left as long as possible as some of them will need to extend the full length of the panel.
The best type of connecting wire is solid-core hook-up wire as this produces a rigid loom which will be self-supporting.
The most difficult part of the project is making the slots in the front panel for the slide controls. One method is to drill a row of holes and file out the metal between. This can be very time-consuming. The only quick method is to mill the slots. For the hobbyist, a fine hax-saw,

PARTS LIST

2 - 150R
2 - 2k2
20 - 4k7
2 - 5k6
4 - 10k
2 - 220k

4 - 10mfd 16v PC electro
2 - 100mfd 16v electro

4 - BC 547

6 - 10k LOG sliders
(specify if you prefer rotary)
4 - 5k lin rotary pots

4 - 6.5mm mono jacks

1 - 8-way RCA socket

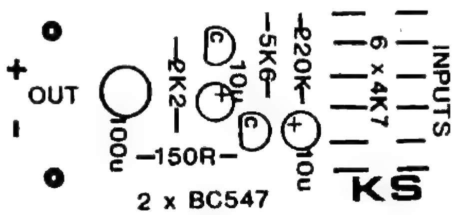
1 - toggle switch SPST
1 - battery snap
tinned copper wire

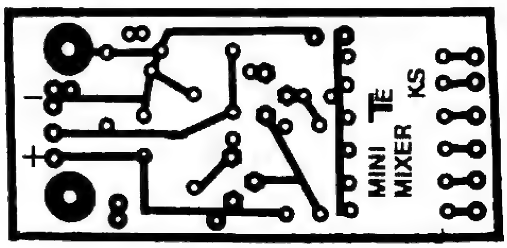
EXPANDER (TO 6 CHANNEL)

4 - 4k7
2 - 10k LOG sliders
2 - 5k lin rotary
2 - 6.5mm mono jacks

Jewellers saw or Coping saw will allow 2 parallel slots to be cut from a hole at one end of the slot and you can terminate at another hole. If all this seems too complicated, you can resort to using rotary pots and save a lot of frustration.

Mount the pots or slide controls and jacks, then complete the wiring as shown in the wiring diagram. Join the ground lugs of the pots and jacks with tinned copper wire before wiring the looms.





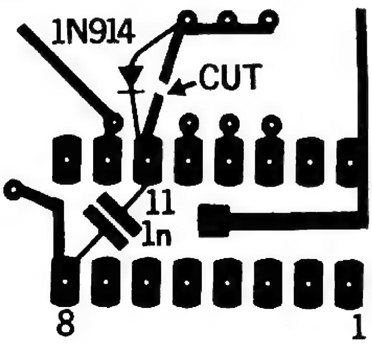
FAULT FINDING THE CLOCK

Some troubleshooting hints:

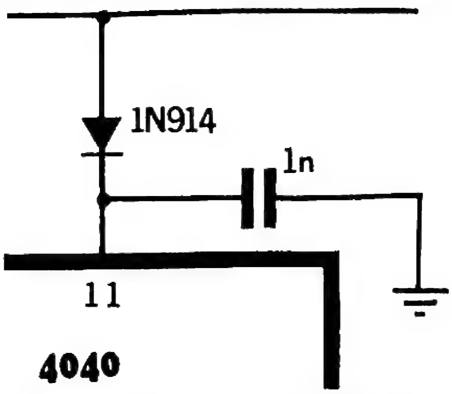
Our clock project in issue 8 produced a few problems for some of our constructors. It is worth while going through these problems and show how we modified the circuit to cater for the different makes of integrated circuits.

THE 4040 COUNTER

Most of the problems with the clock occured in the first section. They revolved around the 4040 IC. In our prototype we used a CD 4040 or MC 14040 and no troubles were experienced. Our next batch of chips were Fairchild f4040 and this is when the trouble started. In the circuit diagram, the counter chip is designed to reset itself via its own inputs. . . when a combination of 7 outputs go HIGH. With the arrangement of self-resetting, the reset pulse is very short. Normally this arrangement would not be used, but to conserve components it is a satisfactory method.
Unfortunately this short pulse was not long enough to fully reset all the internal flip flops in the Fairchild device.
This means that some of the stages had a 'count' still in them after the resetting operation. On the next cycle, the counter would need say 2,500 pulses instead of the full 3,000 to fill the counter before resetting. This meant it took less than 60 seconds to create a full cycle. The result was some of the projects were gaining time. Constructors rang to say the minutes display changed every 45 seconds or so.
Two solutions are possible: You can change the 4040 for a Motorola type or carry out a circuit modification.
WE have produced a mod to increase the pulse length (or effectiveness) to the reset pin.
This mod was introduced when M. Warren and R. Martin had exactly the same fault. The minutes display did not clock at 60 seconds intervals.
So they brought their project to us for help.
This is what we did:
We provided a diode in the reset line of the 4040 and a storage capacitor from pin 11 (the reset pin) to earth. This would lengthen the reset pulse and enable all the flip flops to reset.
The following diagram shows how to cut the track and fit the parts for this modification.



Mounting the components under the 4040 IC.



The modified circuit diagram. Don't use f4040 chips.

FAST-FORWARD TOUCH SWITCH

The fast and slow forward setting feature was a little vague to some readers. Let me explain it more fully: Basically we are using the 3Hz output pin for the slow forward and by touching your finger on the two touch wires, the signal passes through the low resistance of your finger to give the 3 cycles per second clock rate.
By lightly touching these two wires,a voltage divider is set up between your finger and the 1M pull-up resistor.
This action may bring the input of the IC into its linear region and cause it to clock rapidly. This becomes our fast-forward feature.
But this idea did not always work. Sometimes, due to chip characteristics, and sometimes due to individual finger resistance, the 2 clock rates could not be guaranteed.
The solution is to use two push switches. One from pin 5 and one from pin 10 of the 4040 IC.

✶✶✶✶✶

The fault with Mr Pauloff's clock was in the minutes display. It clocked 1,3,6,9,2,5,8,etc.
At each minute, the display would change from 1 to 3 to 6 to 9 etc. The minutes IC (IC2) was receiving noise pulses which clocked the chip rapidly.
The most likely cause of trouble was in the slow clock pulse. Possibly it was due to the rising edge of of the clock being too slow and the 4026 was picking up noise pulses between the LOW and HIGH states.
The circuit components determining the condition on the clock pin of the 4026 are the 1M and 470k voltage dividing resistors. They prodive a "set" on the clock pin and this may be too high for the chip. Try changing the two IC's over or reduce the 470k or 10n capacitor.

Another unusual fault was this clock sequence: 9, 10, 11, 2, 3, 4, 5, etc. The 12 and 1 failed to appear.
This fault is due to the reset resistor between pins 10 and 15 of IC4a, being too HIGH in value. At 100k, it did not allow the voltage on the reset pin to rise enough to reset the two halves of the 4518.
The reason for this lies in the voltage divider network made up of the 100k resistor and the 10k resistor feeing the base of Q3. The voltage across the two diodes in this line (as well as the voltage drop the base-emitter junction) was only just sufficiently high enough to reset the IC. In some cases the diode drops were less and the resulting reset voltage was insufficient.
This resistor can be reduced to 47k or even lower to obtain reliable resetting.

4026's GETTING TOO HOT

The display driving capability of the 4026's varies enormously from one make to another. Some chips remain relatively cool throughout the construction testing and running of the clock, while others get fiercely hot. A simple method of reducing this temperature rise is to add a 10 ohm or 22 ohm resistor in each line of the 12v AC transformer. When the first stage of the clock has been completed, the voltage from the plug pack is about 10v and this is too high for the 4026. As more stages are completed, the voltage is down to about 7v due to poor regulation of the transformer.
When the clock is complete, the supply is about 7v and the 4026's have a better chance of dissipating the heat. Even for a completed clock, a 10 ohm input resistor will reduce the heat generated by the driver chips.

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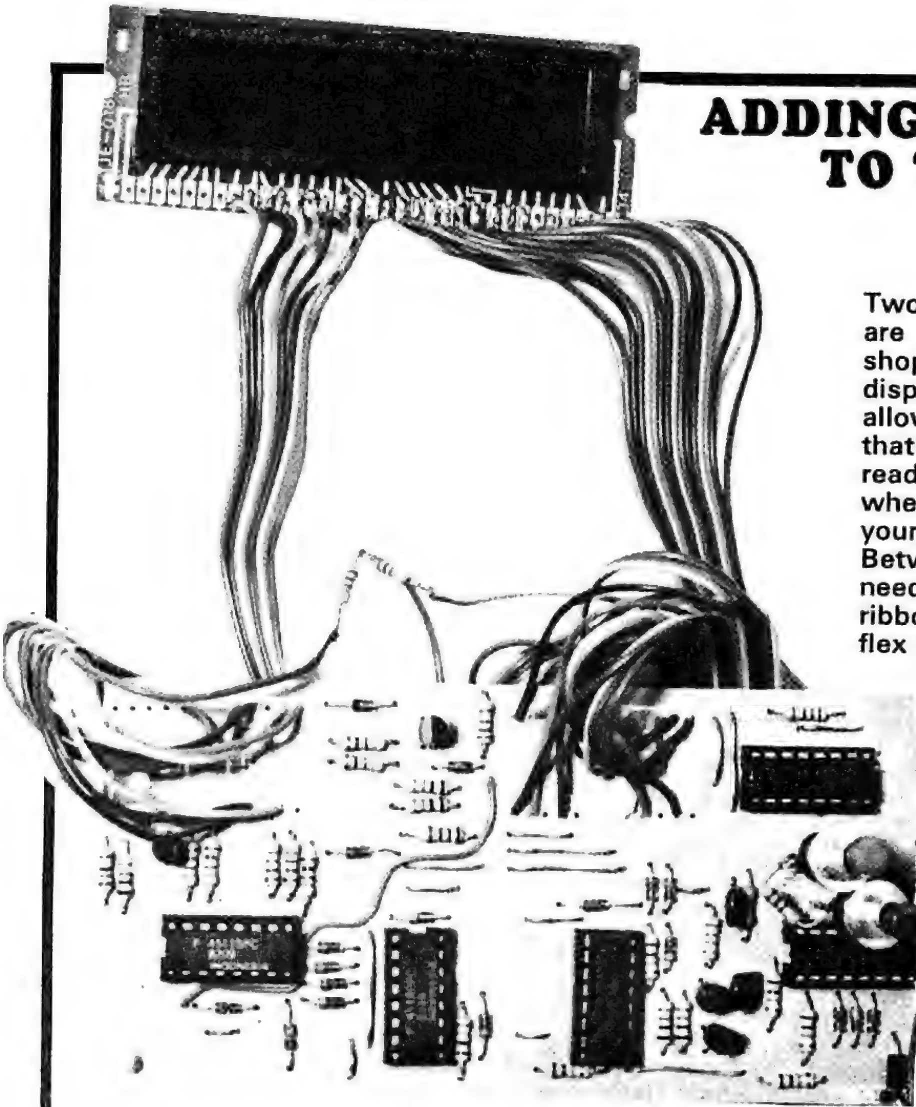
The clock is a very worthwhile project to construct. Because it is presented as a number of separate blocks, the operation of each of the divider stages can be understood. The CD 4026 chips are in plentiful supply at the moment as they have been imported in larger quantities due to the demand. If you are considering building a complex project, this one should be on your list.
In the next issue we will be presenting a computer project and a pre-requisite to its construction will be the construction of at least 5 smaller projects.

The overall feedback from the Clock has been 'complete success'. Bill Street from Billco Electronics constructed his unit in a project box and is sitting on the sales counter as the main time reference. "It keeps perfect time" he said, when I called in to see his newly opened shop in Dandenong.
Three other readers wrote in to say that their clock worked 'first go'.
If you have any problems with this or any other project, just drop us a note or phone for adviso. We will be pleased to assist.

We prefer you to ring for a couple of minutes with each small fault and phone back to say the remedy worked, rather than store up a lot of problems and hit us with them all at once. We don't even mind if you ring 4 or 5 times with different problems on the same project - we know how it is . . . we sometimes have problems too!

Colin.

ADDING A LARGER DISPLAY TO THE CLOCK



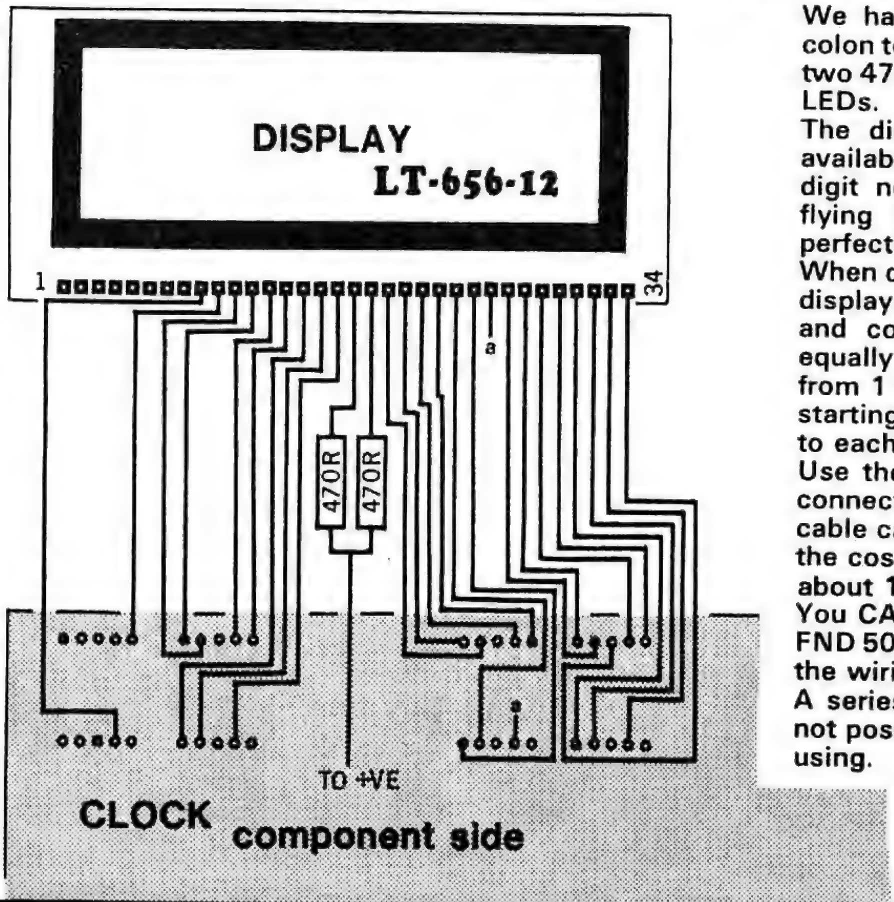
$4.70

Two or three different types of 4 digit displays are available quite cheaply from electronic shops. These can be used for the CLOCK display in place of the FND 500's. This will allow you to produce a remote reading clock so that the works can be housed away from the readout. This will be handy for those situations where the space is at a premium such as on your study desk or workbench.

Between the display and PC board, you will need to run 26 leads. This is best done with ribbon cable however single hook-up wire or flex will be just as good.

Parts:

Any 4-digit Common Cathode display.
30cm - 30-way ribbon cable.



We have added a feature of an illuminated colon to separate the hours from the minutes . . two 470 ohm reistors limit the current to these LEDs.

The display, code numbered LT-656-12, is available from Talking Electronics and is a four digit non-multiplexed unit designed to take flying leads. This suites our ribbon cable perfectly.

When connecting the ribbon cable, start at the display end and cut the cable so that it fans out and connects to each of the solder lands equally. The lands on the display are marked from 1 to 34. Count along the display for the starting point (which is pin 9) and then connect to each land up to pin 34.

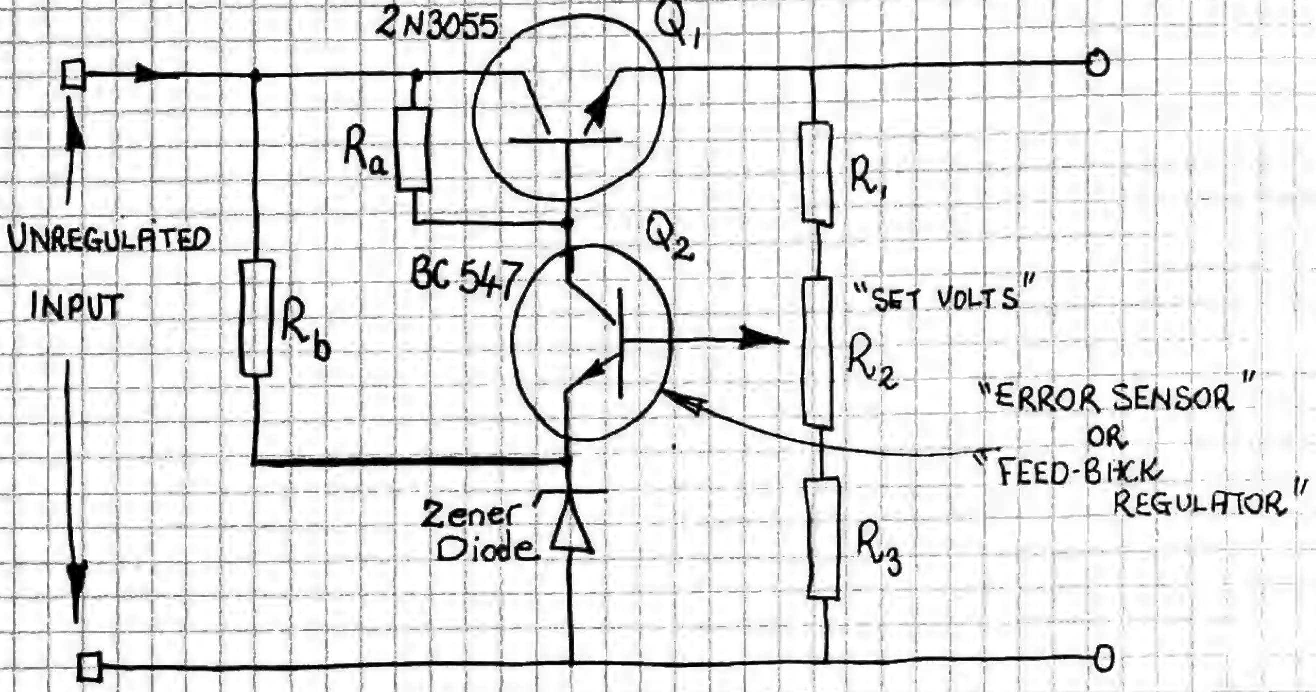
Use the colour of each lead to identify each connection on the PC board. The connecting cable can be as long as you like, but take into the cost of the cable and you should settle on about 100cm or less.

You CANNOT run the remote display and the FND 500's on the PC board at the same time as the wiring is connecting the LEDs in parallel. A series configuration would be allowed but not possible with either of the displays we are using.

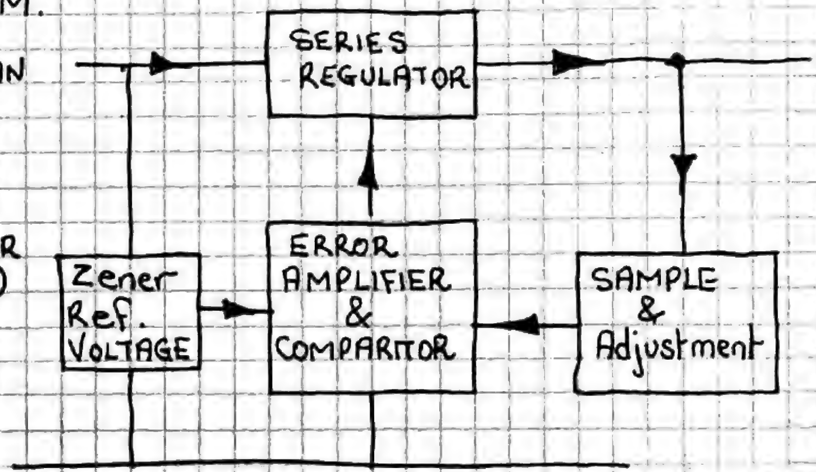
THE OP-AMP IN POWER SUPPLIES

FIRSTLY A LOOK AT THE TRANSISTOR VERSION OF AN "ERROR SENSOR" THEN WE WILL SEE HOW AN OPERATIONAL AMPLIFIER FITS IN.

THE CIRCUIT SHOWS A SERIES PASS TRANSISTOR 2N3055 AND AN "ERROR SENSOR" TRANSISTOR BC 547 (WIRED TO FORM A FEED-BACK REGULATOR.)



THE WAY IN WHICH THE CIRCUIT WORKS CAN BEST BE EXPLAINED WITH THE AID OF A BLOCK DIAGRAM.



THE SERIES PASS TRANSISTOR CAN BE CONSIDERED AS A VARIABLE RESISTANCE, SO THAT AT ANY STAGE IT HAS AN "EFFECTIVE RESISTANCE" & A VOLTAGE IS DROPPED ACROSS THE COLLECTOR - EMITTER LEADS (C-E JUNCTION)

IF THE CURRENT DEMAND (THE CURRENT THROUGH THE LOAD) INCREASES, THE VOLTAGE ACROSS THE PASS TRANSISTOR (C-E LEADS) INCREASES & THE OUTPUT VOLTAGE TO THE LOAD WOULD DECREASE.

THE RESISTORS R_1, R_2 & R_3 FORM A VOLTAGE DIVIDER ACROSS THE OUTPUT, & THE CENTRE ARM OF THE VARIABLE RESISTOR R_2 WILL DETECT THIS DROP IN VOLTAGE. [NOT THE FULL VOLTAGE DROP BUT STILL A VOLTAGE DROP].

INITIALLY Q_2 IS ACTING AS A COMPARITOR, COMPARING THE ACCURATE ZENER REFERENCE VOLTAGE WITH THE "SET VOLTS," TO CONTROL THE VOLTAGE ON THE BASE OF Q_1.

WHEN THE POWER IS APPLIED, Q_1 IS FULLY TURNED ON VIA R_a & THE OUTPUT VOLTAGE RISES UNTIL Q_2 TURNS ON VIA THE VOLTAGE ON THE SLIDER OF R_2. THE BC547 IS PRODUCING A VOLTAGE DROP BETWEEN COLLECTOR AND EMITTER TERMINALS AND THIS IS ADDED TO THE ZENER VOLTAGE.

THE BASE OF THE 2N3055 "SEES" THIS VOLTAGE AND PRODUCES AN OUTPUT AT THE EMITTER WHICH IS ·6V LESS THAN THE BASE VOLTAGE.

THIS OUTPUT VOLTAGE IS PASSED TO THE BC 547 & THE 2N3055 TRANSISTOR MAY ADJUST ITS COLLECTOR VOLTAGE UNTIL A STATE IS PRODUCED WHICH IS STABLE FOR THE SETTING OF R_2.

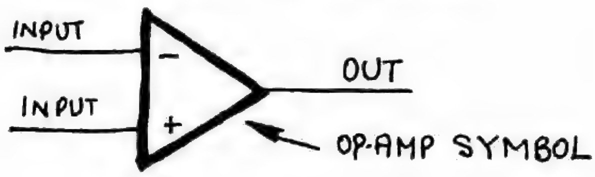
IF THE LOAD-CURRENT INCREASES, THE VOLTAGE ON THE BASE OF Q_2 FALLS SLIGHTLY & Q_2 TURNS OFF SLIGHTLY SO THAT THE VOLTAGE ON THE BASE OF Q_1 RISES VIA R_a. Q_1 TURNS ON HARDER TO INCREASE THE OUTPUT VOLTAGE.

THE "ERROR AMPLIFIER" Q_2 IS WELL NAMED. IT DETECTS ANY DIFFERENCE BETWEEN THE ZENER VOLTAGE & THE REFERENCE VOLTAGE. IF THE REFERENCE VOLTAGE (KNOWN AS THE ERROR SIGNAL) CHANGES, THE TRANSISTOR AMPLIFIES THIS SIGNAL AND FEEDS IT BACK TO THE BASE OF THE SERIES PASS TRANSISTOR TO ADJUST ITS EFFECTIVE RESISTANCE".

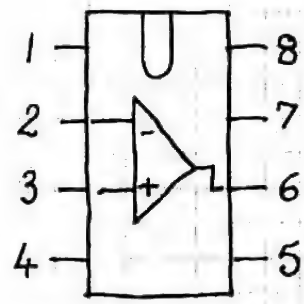
THE SAME ERROR DETECTION CAN BE PRODUCED BY AN OP-AMP, but FIRSTLY LET'S LOOK AT:

HOW THE OP-AMP WORKS

THE 3 SIGNAL LINES ARE:



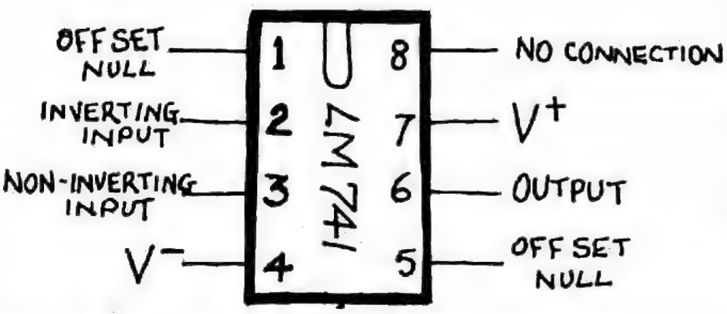
OP-AMP DIAGRAM.



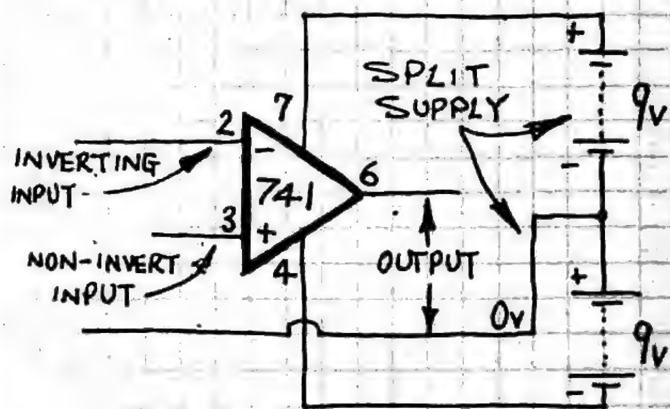
THE LM741 OP-AMP

THE OP-AMP WE WILL BE USING IS A 741 OP-AMP.

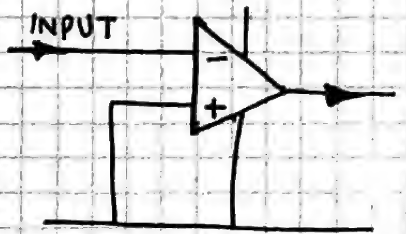
WE WILL BE USING THE 8 PIN VERSION:



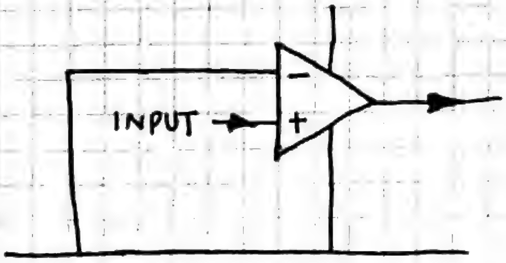
THE 741 OP-AMP IS DESIGNED TO OPERATE FROM A SPLIT POWER SUPPLY:



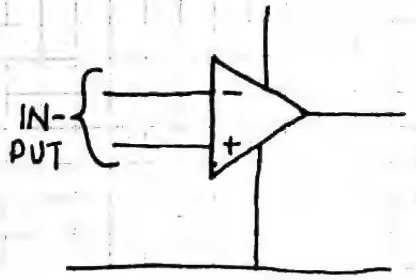
THE OP-AMP CAN BE DESIGNED TO OPERATE AS AN INVERTING AMPLIFIER (+ CONNECTED TO 0v), NON INVERTING AMPLIFIER (− TO 0v) OR AS A DIFFERENTIAL AMPLIFIER — (AS PER OUR NEXT POWER SUPPLY CIRCUIT.)



741 AS AN INVERTING AMPLIFIER



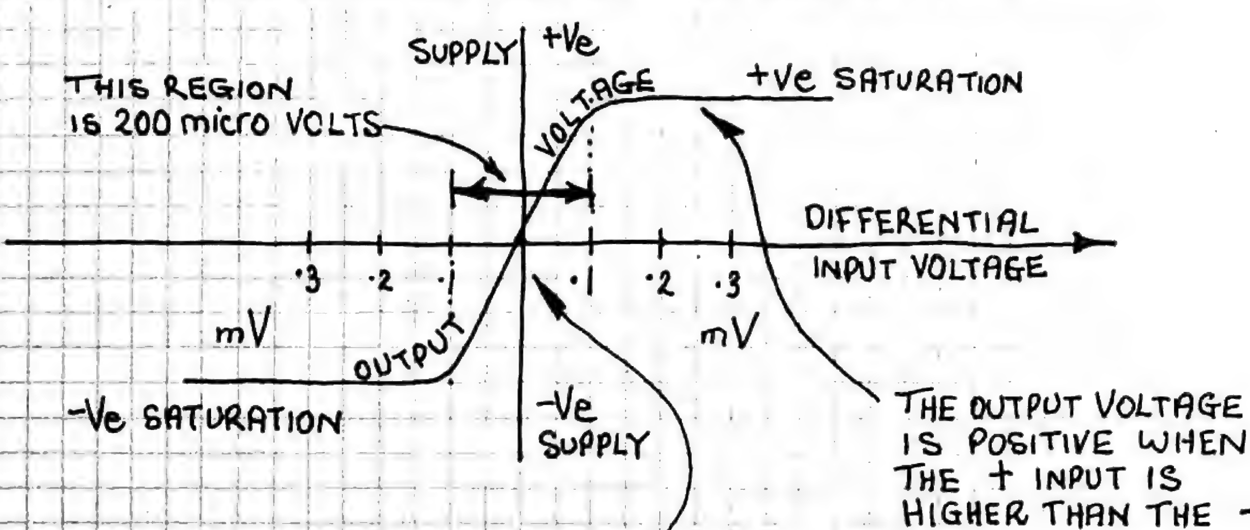
741 AS A NON-INVERTING AMPLIFIER.



741 AS A DIFFERENTIAL AMPLIFIER

THE OP-AMP IS DIRECTLY COUPLED THROUGHOUT AND HAS A VERY HIGH GAIN. (TYPICALLY 100,000) AND THIS MAKES THEM VERY SENSITIVE & IDEAL AS "ERROR SENSORS" BECAUSE THE SENSING RANGE FOR THE OP-AMP IS ONLY ABOUT 100 MICRO-VOLTS. AS SHOWN IN THE GRAPH BELOW:

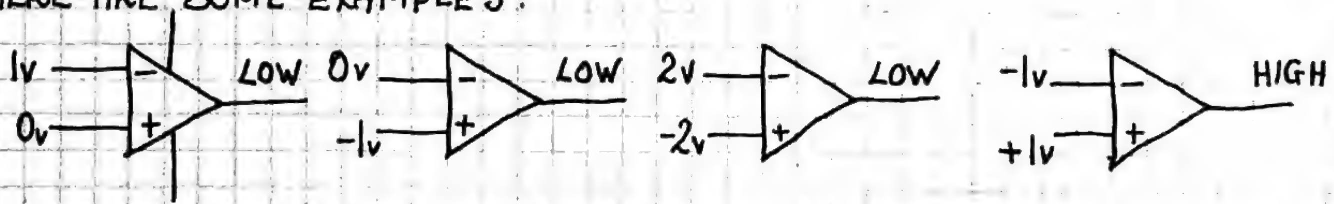
THE FOLLOWING GRAPH SHOWS HOW THE OUTPUT VOLTAGE CHANGES ACCORDING TO THE VOLTAGE ON THE TWO INPUTS.



THE OUTPUT WILL BE ZERO WHEN THE DIFFERENCE BETWEEN THE TWO INPUT VOLTAGES IS ZERO. AS THE VOLTAGE ON THE + INPUT INCREASES THE OUTPUT GOES HIGH. IF THE − INPUT IS TAKEN TO THE SAME POSITIVE VALUE, THE OUTPUT WILL FALL TO ZERO

IF THE − INPUT IS TAKEN NEGATIVE, THE OUTPUT WILL GO MINUS. IF THE + INPUT IS TAKEN TO THE SAME NEGATIVE VALUE, THE OUTPUT WILL BECOME ZERO. (VOLTS)

HERE ARE SOME EXAMPLES:



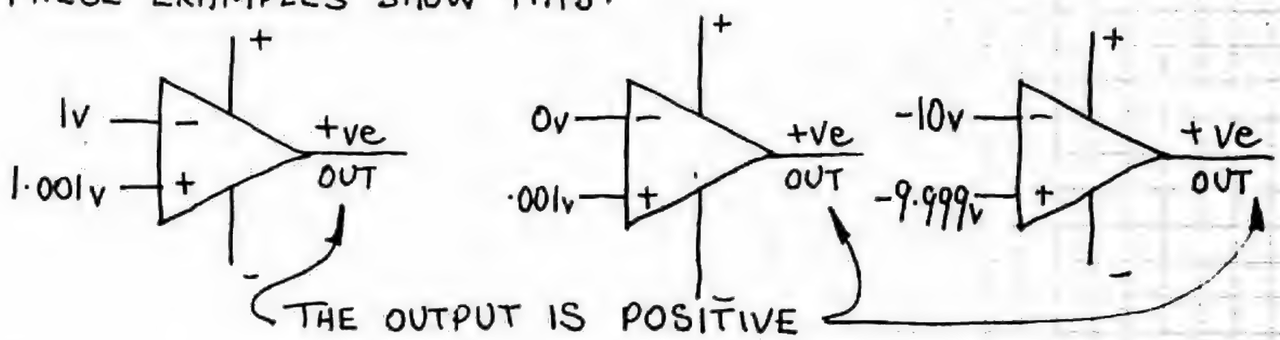
DID YOU FULLY UNDERSTAND THE ANSWERS TO THE 4 EXAMPLES ON THE PREVIOUS PAGE?
IF NOT, WE WILL EXPLAIN HOW THE OUTPUT CHANGES ACCORDING TO THE VOLTAGE ON THE INPUTS.
THE 741 OP-AMP USES A SPLIT POWER SUPPLY ie. +9v ON PIN 7 & −9v ON PIN 4. WITH THIS TYPE OF SUPPLY, THE OUTPUT WILL GO HIGH: TO 9v & LOW: TO −9v. IT WILL SWING 18V.
THIS 18V SWING OCCURS WHEN THE INPUT VOLTAGE CHANGES 200μV.
IN THIS 200μV REGION THE OP-AMP IS WORKING IN ITS <u>LINEAR RANGE</u>.

POWER SUPPLY CIRCUITS USE THE OP-AMP IN ITS LINEAR RANGE & THUS A VERY SMALL CHANGE ON THE INPUT WILL PRODUCE A LARGE CHANGE ON THE OUTPUT. OF THE OP-AMP (NOT THE POWER SUPPLY)

BUT THE OUTPUT CAN BE POSITIVE OR NEGATIVE, ACCORDING TO THE VOLTAGE ON THE INPUTS.
YOU MUST BE ABLE TO DETERMINE THE SIGN OF THE OUTPUT WHEN THE 741 IS USED AS A <u>COMPARITOR</u>. [IN THE LINEAR RANGE]

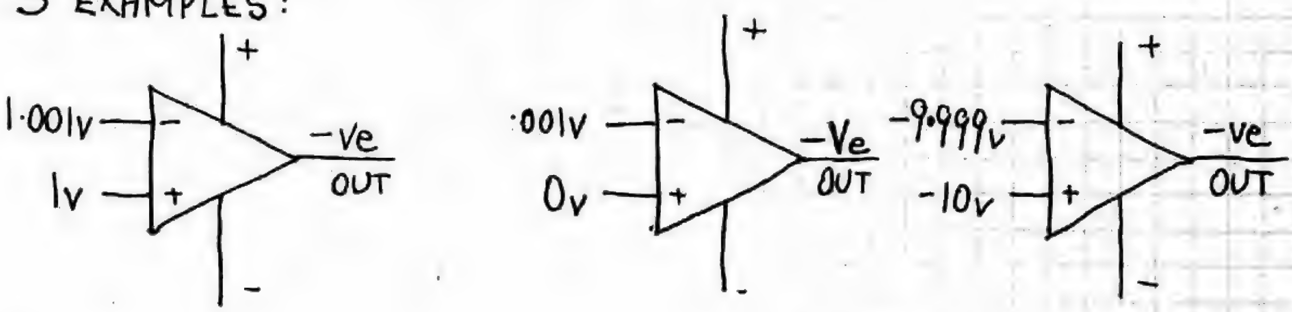
IN THE LINEAR REGION: IF THE (+) INPUT IS HELD WITHIN 200μV ABOVE THE (−) INPUT, THE OUTPUT WILL BE A POSITIVE VOLTAGE WHICH IS PROPORTIONAL TO THE DIFFERENCE BETWEEN THE TWO INPUTS.

THESE EXAMPLES SHOW THIS:



IF THE (−) INPUT IS HELD WITHIN 200μV ABOVE THE (+) INPUT, THE OUTPUT WILL BE A NEGATIVE LINEAR VOLTAGE PROPORTIONAL TO THE DIFFERENCE BETWEEN THE INPUT LINES.

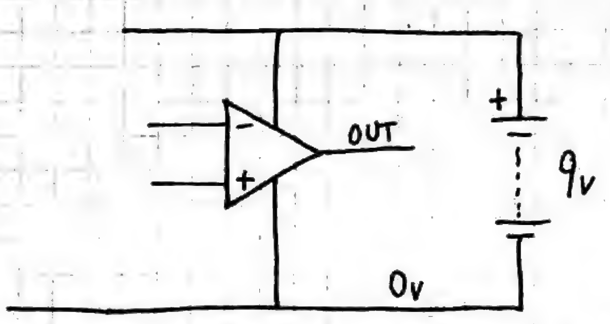
3 EXAMPLES:



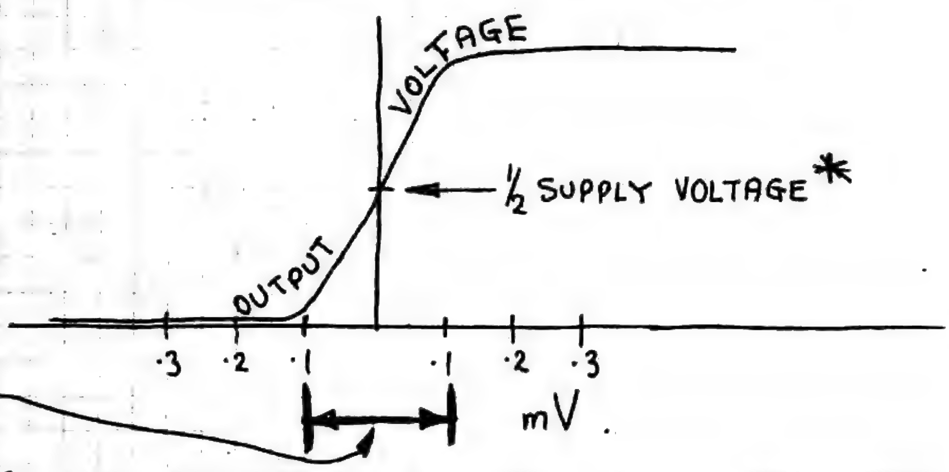
SUMMARY

IF THE NON-INVERTING INPUT (+) HAS THE HIGHER VOLTAGE:
THE OUTPUT WILL BE POSITIVE.
IF THE INVERTING INPUT (−) HAS THE HIGHER VOLTAGE:
THE OUTPUT WILL BE NEGATIVE.

THE OP-AMP WILL ALSO OPERATE FROM A SINGLE POWER SUPPLY:

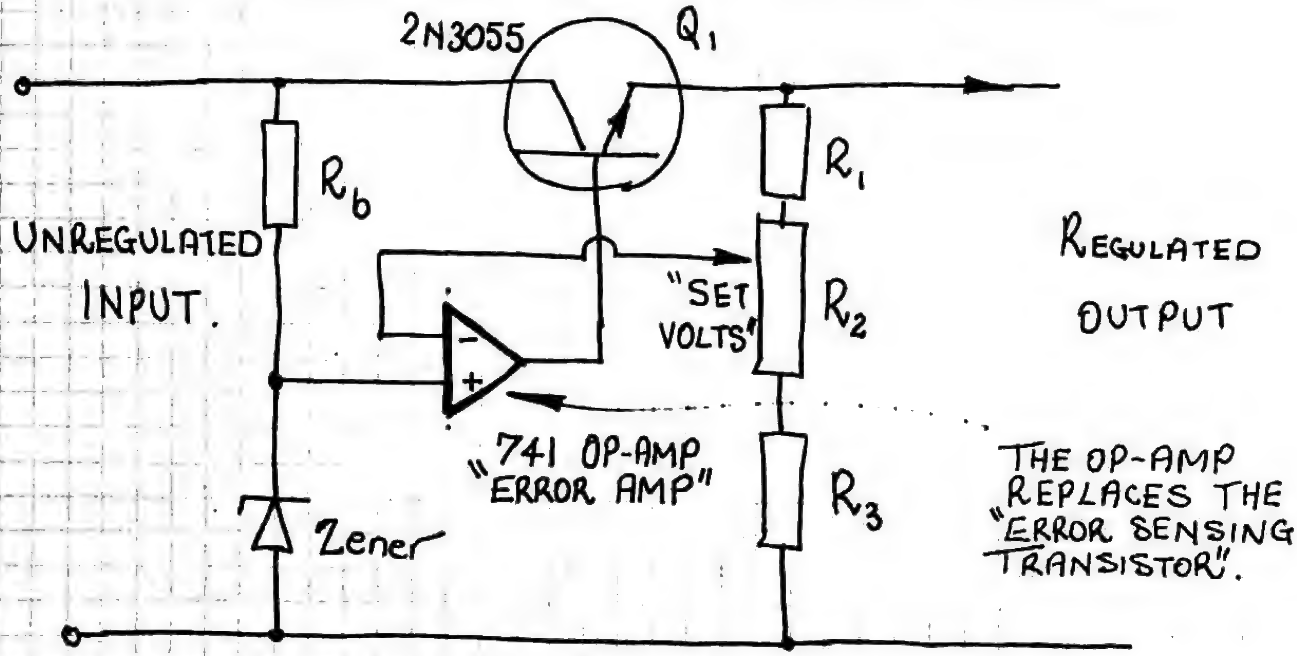


THE OUTPUT WAVEFORM:



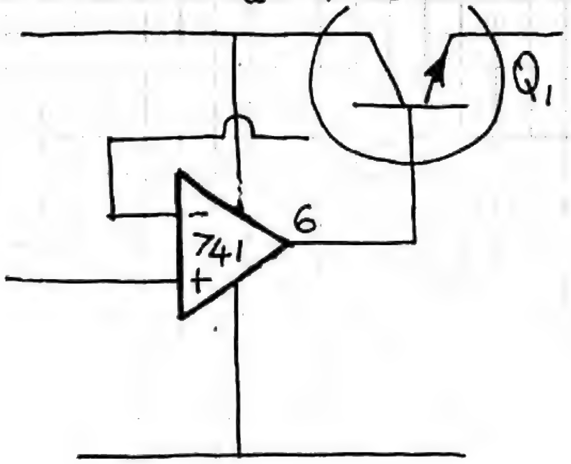
* AT ZERO DIFFERENCE BETWEEN INPUTS THE OUTPUT WILL BE ½ RAIL VOLTAGE.
THE INPUT VOLTAGE DIFFERENTIAL OPERATING RANGE IS ABOUT ·2 MILLIVOLTS FOR FULL OUTPUT SWING. (= 200 micro VOLTS)

AN OP-AMP WILL REPLACE THE ERROR SENSING TRANSISTOR



TWO POINTS NEED EXPLAINING:

(i) TWO POWER RAILS FOR THE OP-AMP ARE NOT DRAWN & IT MAY BE DIFFICULT TO SEE HOW THE OP-AMP FUNCTIONS.
(ii) RESISTOR R_a HAS BEEN OMITTED. - WHY?



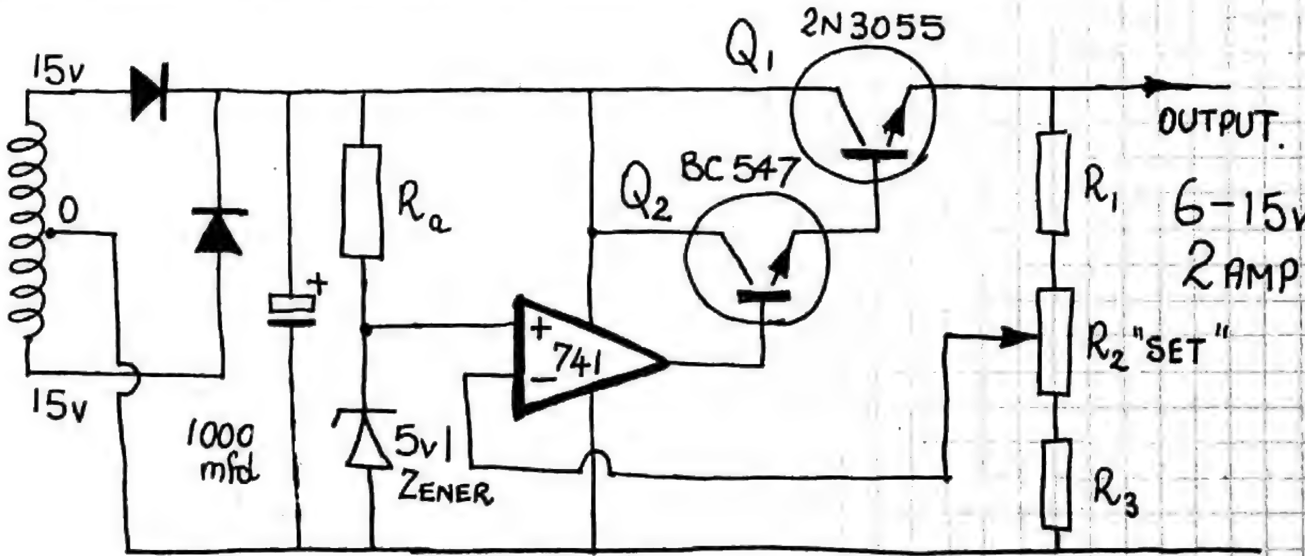
WHEN THE POWER RAILS FOR THE OP-AMP ARE INCLUDED - IT IS EASY TO SEE WHERE THE BASE OF THE 2N3055 GETS ITS "TURN-ON" VOLTAGE FROM — THROUGH THE OP-AMP POWER RAIL & PIN 6.

& THIS MEANS R_a IS NOT REQUIRED.

WHEN THE CIRCUIT IS SWITCHED ON, THE VOLTAGE ENTERING THE NON-INVERTING INPUT (+) TURNS THE OP-AMP ON FULLY TO DRIVE THE 2N3055 INTO FULL CONDUCTION. THE OUTPUT OF THE POWER SUPPLY RISES UNTIL THE FEEDBACK VOLTAGE FROM THE "ADJUST" CONTROL R_2 REDUCES THE TURN-ON VOLTAGE FROM THE OP-AMP & THE OUTPUT VOLTAGE SETTLES TO THE "SET" VOLTAGE.

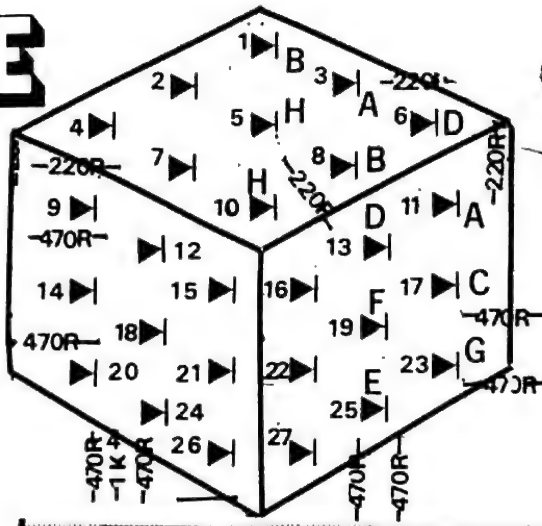
BUFFERING THE OP-AMP

AN OP-AMP IS CAPABLE OF DRIVING A 2N3055 DIRECTLY. THIS WILL PRODUCE A POWER SUPPLY WITH A LIMITED OUTPUT CURRENT HERE IS WHY:
THE OP-AMP CAN DELIVER ABOUT 25mA. THIS CURRENT WILL DRIVE THE BASE OF THE 2N3055 & IF THE CURRENT GAIN OF A 2N3055 IS 20, THE OUTPUT OF THE POWER SUPPLY WILL BE $25 \times 20 = 500$ mA. TO INCREASE THIS CURRENT WE NEED AN AMPLIFIER AS FOLLOWS:



POWER SUPPLY WITH CURRENT AMPLIFYING TRANSISTOR Q_2.

SOLVING THE:
CUBE PUZZLE



The cube puzzle has two levels of play. In these notes we will be describing the solution of the EASY level. The HIGH level (or HARD level) will be an extension of these instructions and we will not spoil the puzzle by giving away the complete secret.

The relevant part of the circuit diagram has been reproduced along with the LED display. All the output pins of the BINARY COUNTER and SHIFT REGISTER have been labelled and each of the LEDs in the display has been given a number. The outputs of the shift register have been labelled A to G to distinguish them from the counter.
Now that all the outputs are labelled, it is an easy matter to describe the sequence of events.

By now you will be aware of the functions of the 4 buttons. Referring to the circuit diagram in issue 8. The identification of the push buttons is as follows:
BUTTON A: This is the count button. It is situated closest to one end of the board. Pushed once, it will clock the counter one count. During each push, the 10mfd electrolytic receives a small charge. Across the electrolytic are two resistors in series. These bleed the voltage off the electrolytic but if the charging-up pulses are close together, the electro gradually charges up faster than it decays and when it reaches ⅔ of the rail voltage, a clock oscillator created by the 1mfd and inverter between pins 13 and 12, will come into operation and give the binary counter a number of counts. This continues until the voltage on the 10mfd electrolytic is bled to below ⅓ of the rail voltage.

BUTTONS B & C are toggle buttons. They toggle the count pulses entering the 4040 binary counter.
Button C also feeds the first half of the shift register and an understanding of how shift registers work is needed to complete the HARD STAGE of the puzzle. It will also be of benefit to construct the DIGI-CHASER as it uses a shift register in its output.
The second half of the shift register in the Cube Puzzle creates all the difficulty. And this will be covered in a minute.

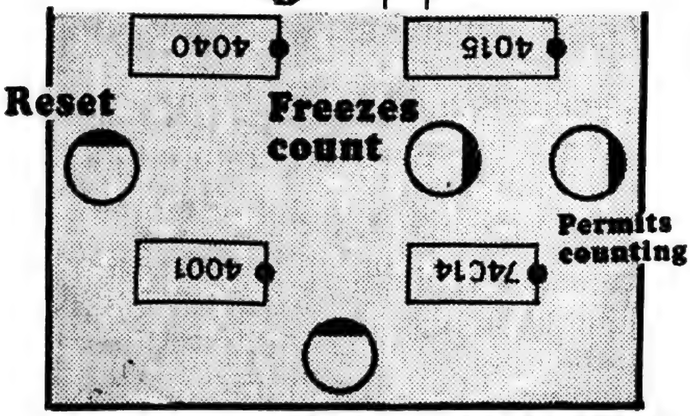
BUTTON D is the reset button. It will turn all the LEDs off, so be warned. Don't touch it once you have started play.

When you turn the puzzle on, some of the LEDs will light up. Push the reset button to start with a blank display.
Pushing the count button will give you individual counts and then a number of high-speed counts. To keep to individual counts, you will have to push the button at longer intervals and keep the push-time very short. Soon you will understand the priority of the 15 LEDs connected to the binary counter. Each output has twice the priority of the output before it. This is why they go on and off in a pattern. This would make more sence if they were laid out in binary form. But this would lessen the impact of the puzzle.

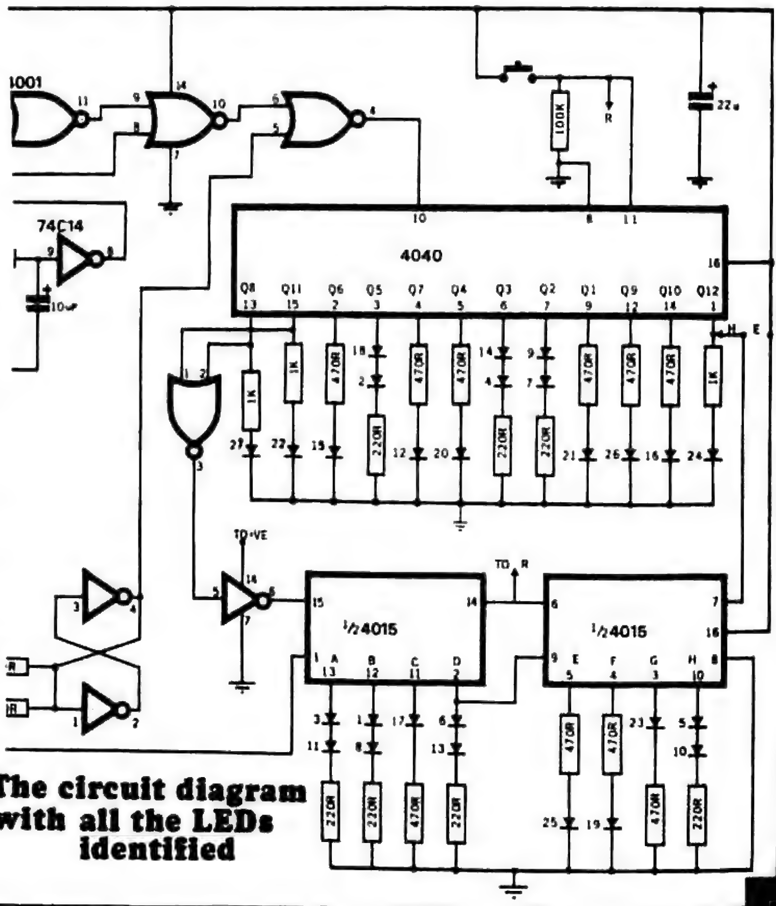
Your problem is to get into the SHIFT REGISTER.
The first "indicator" to look for is LED 22 or 27. When either one or both of these are lit, Pin 15 (the DATA INPUT LINE) will be HIGH. This means a toggling action on pin 1, (the CLOCK line) will allow a HIGH to be registered at output A and If B and C are toggled three more times, the four HIGHs will be shifted to outputs A, B, C and D. When output D goes HIGH, the first output of the second shift register will also record a HIGH because it is wired somewhat in reverse.
For the second half of the shift register, the DATA pin is held HIGH and the CLOCK line is toggled. This means that only a constant stream of HIGHs can be entered into the second shift register.
So, with the first operation, we fill 5 outputs.
The next 'indicator' to look for is the non-illumination of LEDs 22 and 27. When buttons B and C are toggled, outputs A, B, C and D will go low but output E will remain HIGH.
For the next step, LEDs 22 or 27 should be illuminated and the shift register can once again be clocked. The result will be 6 HIGHs. Continue this sequence of toggling the second shift register until all 8 outputs are HIGH and then carefully clock the binary counter to completely fill the display. When all the LEDs are on, lock the display by pushing button B and this will freeze the counting.

I won't spoil the puzzle by explaining how to solve the difficult level. You should be able to work out the sequence for yourself, now that you have all the listings of the pins and LEDs.

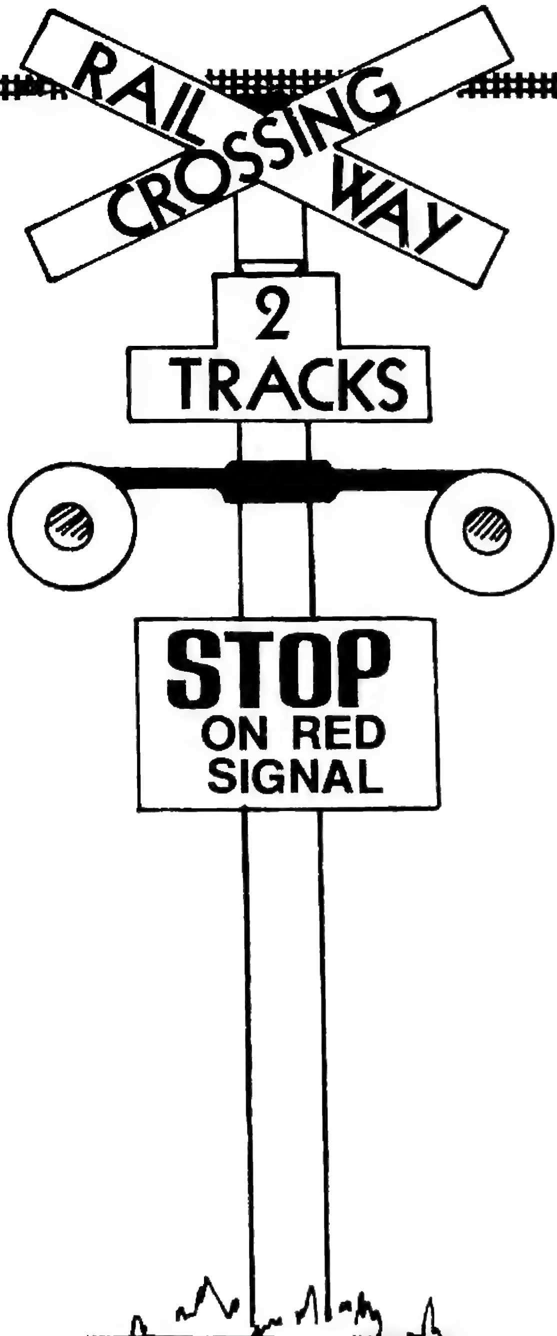
HAPPY FRUSTRATION!



Single count and oscillator



The circuit diagram with all the LEDs identified



TRAIN SIGNALS

COMPONENTS & PC BOARD $8

Model Railroad enthusiasts will jump at this project. It combines TWO features in the one circuit.

One output operates flashing BOOM GATE lights and the other controls train signals or the STOP, CAUTION, GO lights at traffic intersections.
The most interesting feature of the project is its completeness. It can be connected directly to the AC output of a train transformer as it has its own inbuilt power supply.

A full-wave bridge and smoothing electrolytic have been included on the board as most of the AUX. power outputs on model layouts are for street lighting and are AC.
This is usually 12v and when rectified, the resulting DC will have a higher value than that allowed for a CMOS chip. To overcome this we have included a voltage dropping network which still allows the pea lamps to receive the full input voltage while the chips receive a lower voltage.

In a model shop, the cost of a circuit to flash warning lamps is about $8 and a traffic signal circuit, about $15. You can make both these control circuits for a lot less than half.

We found it very difficult to purchase a set of traffic lights. The only signal sets available were for train control and these had the green lamp at the top and the red lamp at the bottom. You can make your own traffic signals by combining components from the train signals with square plastic section from a construction set.
The TRAFFIC SIGNAL circuit will drive two sets of warning lamps and two sets of traffic signals. One traffic signal can be out of sequence with the other simply by connecting the red output transistor to the red lamp of one signal and the green lamp of the other.
A complete set of lights for an intersetion would be very expensive but not beyond the possibilities for this project. The output transistors can be taken to an additional emitter-follower to supply the required current.

PARTS LIST

1 - 1k
1 - 2k2
14 - 10k
1 - 68k
1 - 100k

1 - 10mfd 16v PC electro
2 - 100mfd 25v PC electros

4 - 1N4001 or 4002 diodes
5 - BC 547 transistors

1 - 555 timer IC
1 - CD 4017 decade counter IC

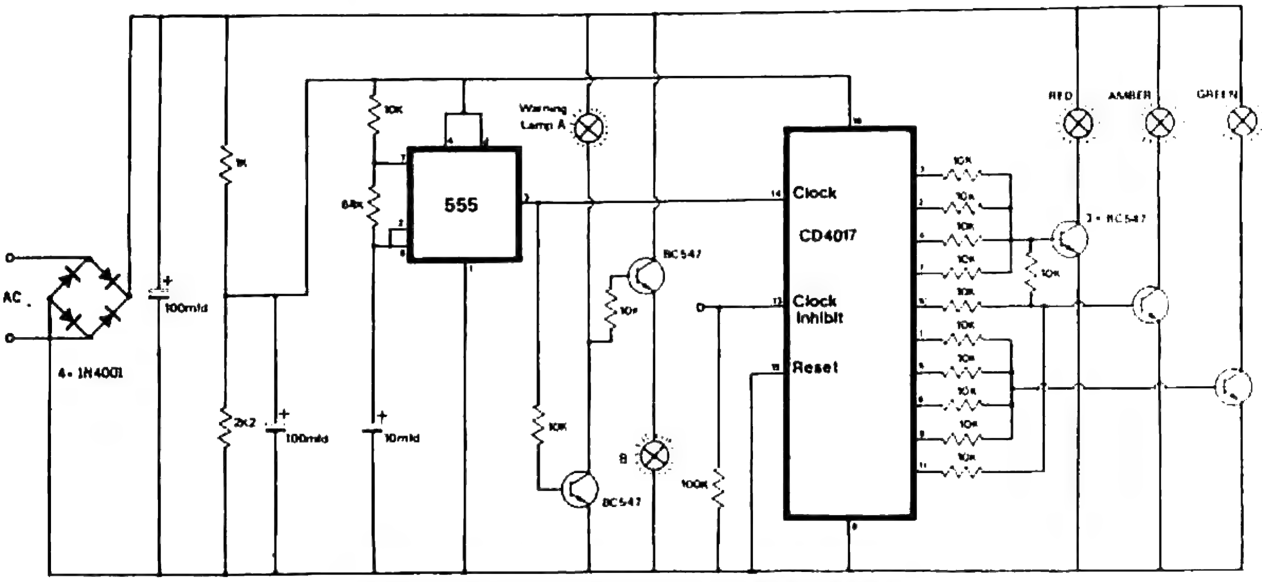
Tinned copper wire

1 - 8 pin IC socket
1 - 16 pin IC socket
1 - "TRAIN SIGNALS" PC board

HOW THE CIRCUIT WORKS

The full-wave bridge recifier made up of 4 1N 4001 diodes and the 100mfd storage electrolytic provide a fairly smooth DC output from the AC lighting line of any model train transformer.
The reason for the full wave rectifier instead of a half wave rectifier is the loading on the circuit. A half wave rectifier (made up of a single diode) would not suppy the current needed because it picks up only every half cycle. The lamps would flicker in step with the flashing lamps. A full wave rectifier has greater current capability and the resulting voltage is maintained at a more constant level.

In addition, a full wave circuit can be connected to the 2 AC leads either-way-round. A half-wave circuit will only operate when connected jumper from earth to the mid-point.
When pin 7 is doing nothing, the electrolytic charges up via the 10k and 68k resistors which are in series.
As soon as it reaches ⅔ of the voltage on pin 8 of the chip, pin 7 is connected to earth via the circuitry inside the chip.
This allows the voltage to be bled off via the 68k resistor.
When the voltage on the electrolytic reaches ⅓ of the supply voltage, pin 7 is allowed to sit between the two rsistors and has no efffect on the circuitry. Pins 2 and 6 are detecting this ⅓ and ⅔ rail voltage so that the capacitor will be charging and discharging in this narrow voltage range.
The output pin 3 of the 555 will be turning on and off during this sequence of events and will have an ON time equal to the OFF time.



TRAIN SIGNALS CIRCUIT

in one direction. In reverse, the circuit will not receive any supply current. The diode will be acting as a protection diode.
Across the 100mfd electrolytic is a voltage dividing network made up of a 1k and 2k2 resistor. Theoretically these divide the voltage in the ratio of their values so that ⅔ of the voltage appears across the chips. In practice, the current flow through the 1k resistor drops this voltage to 50% and in our prototype this was 6 to 7v.
The 555 operates as a square wave oscillator having an equal mark-space ratio with a frequency of about one cycle per second.
The way in which the 555 works is very simple.

Pins 2 and 6 are voltage detection pins and have no effect on the charging of the 10 mfd electrolytic. Pin 7 either sits between the 68k and 10k resistors, and does nothing, or is connected to earth so that the connection of the two resistors is the same as running a

The equal 'mark-space' ratio allows DING-DONG lamps to be connected to the output. The first output transistor is a common emitter transistor so that when the output pin 3 goes HIGH, the transistor will turn ON. The second lamp is driven by an emitter-follower and is connected directly to the first transistor.
When the first lamp is ON, the collector of the first driving transistor is very near ground potential. This brings the base of the second transistor near to earth and the emitter will also be LOW. When the first lamp is extinguished, the collcetor will have a HIGH voltage on it because the transistor will be turned OFF. This HIGH voltage, (coming through the first lamp) will pass through the 10k resistor (on the base of the second transistor) and will draw the base up towards the power rail. The transistor will drag the emitter up with it and this will turn on the second lamp. Another way of putting it is: The emitter will only be .6v behind (lower) than the base.

The CD 4017 is a Decade Counter and has 10 outputs. On each output we have placed a 10k resistor. A 10k resistor is called a "DESIGN" resistor. In other words it is purely a nominal value and could be as high as 15k or as low as 8k2 without altering the operation of the circuit.It is intended to provide a "turn-on" voltage for the buffer transistors. If we take the first output (pin 3) we have a very complex resistor network which becomes a voltage divider. Three 10k resistors are in parallel to ground and another 10k resistor feeds more 10k resistors in parallel.

Without getting complex, you can briefly work out that the voltage on the base of the buffer transistor will be about ¼ to one-fifth of the voltage at pin 16. If the chip is supplied with 6v, the voltage reaching the base will be about 1v and since the transistor requires only about .65v to fully turn on, we will be able to saturate the transistor.

The same applies to the second, third and fourth outputs. The amber buffer will easily turn on and the green buffer will also have cient voltage on its base to illuminate the green pea lamp.

Since each output is HIGH for about 1 second, the complete cycle for the TRAFFIC LIGHTS is 10 seconds.

The 4017 also has a feature called CLOCK INHIBIT. When pin 13 is taken HIGH , the 4017 will stop counting. This will freeze the lights instantly.

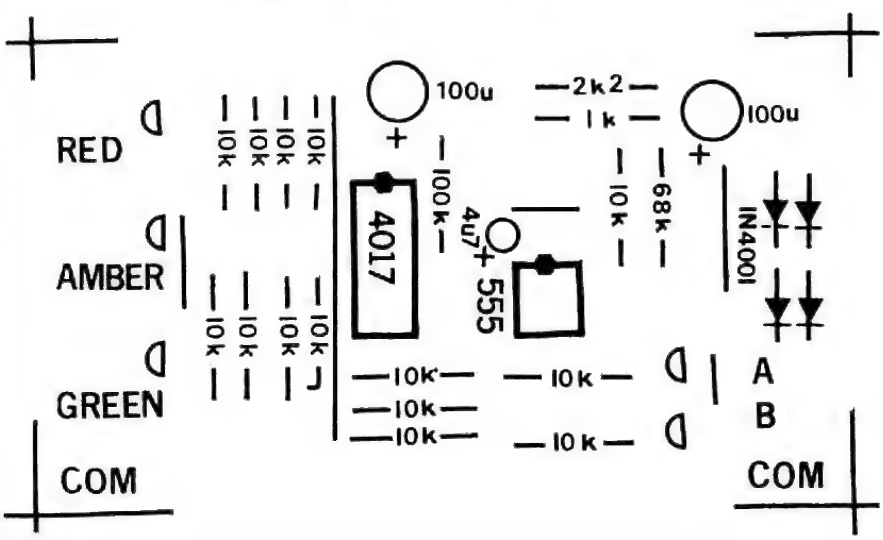
This pin is taken to rail voltage (pin 16) via either a push switch or toggle switch to create the freeze effect. The warning lamps will remain operating during this time.

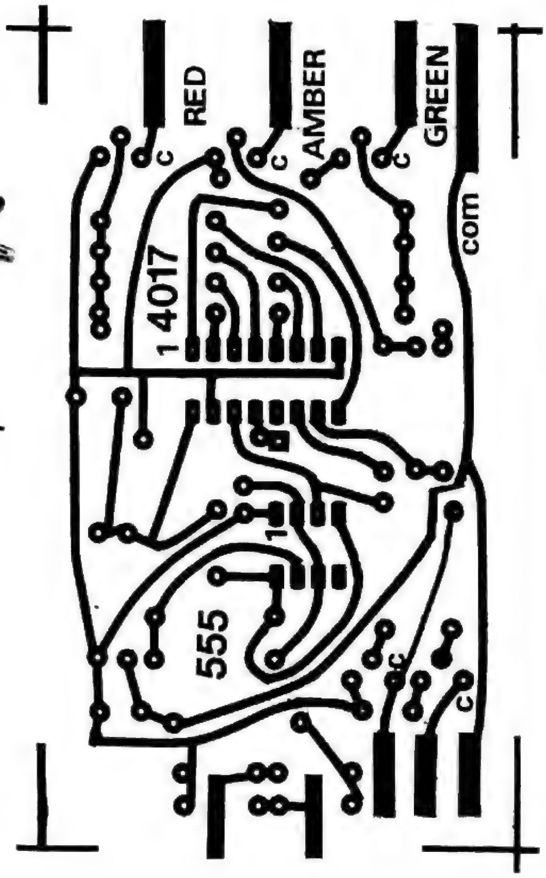
ASSEMBLY

Mount the components on the PC board as shown in the layout diagram. The overlay on the board will help with the positioning of the semiconductors and electrolytics as they must be inserted the correct way around.

IC sockets are suggested for this project as high voltage spikes can sometimes damage a chip and it is far easier to replace an integrated circuit when it is in a socket, rather than de-solder it.

The completed project ready for installing onto a train layout.

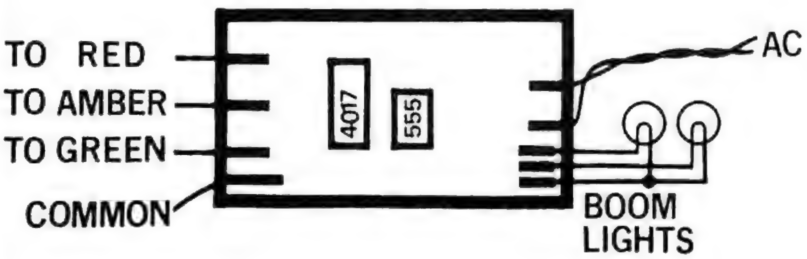




The first items to fit onto the board are the jumper links. Five links are needed for this project and these should be made from tinned copper wire. Make sure the wire is straight before forming it into a 'U' shape and press the link firmly onto the board while soldering to give a near appearance.
The 4 diodes are all fitted the same way around and the silver stripe at one end indicates the cathode. This is shown as a bar on the overlay and as a double-check, the stripe goes towards the 'com' line.
The positive lead of the three electrolytics are identified on the overlay. You will need to be careful as the negative is the lead which is identified on the electrolytic itself. As a check, the longest lead of the electrolytic is the positive.
The 5 transistors are all BC 547's and they all face the same direction. If the leads of the transistors you have purchased are staggered, they will fit into the holes only one way around. If the leads are not "pre-formed" you will need to look at the 'D' mark on the overlay to identify the 'flat' on the transistor.
The resistors can be inserted either way around as they are a non-polar component (meaning they are not sensitive to the direction of the flow of current). It is suggested that the 100k, 68k and 1k resistors are fitted first. Then the remaining 10k resistors can be inserted without any mistake occuring.

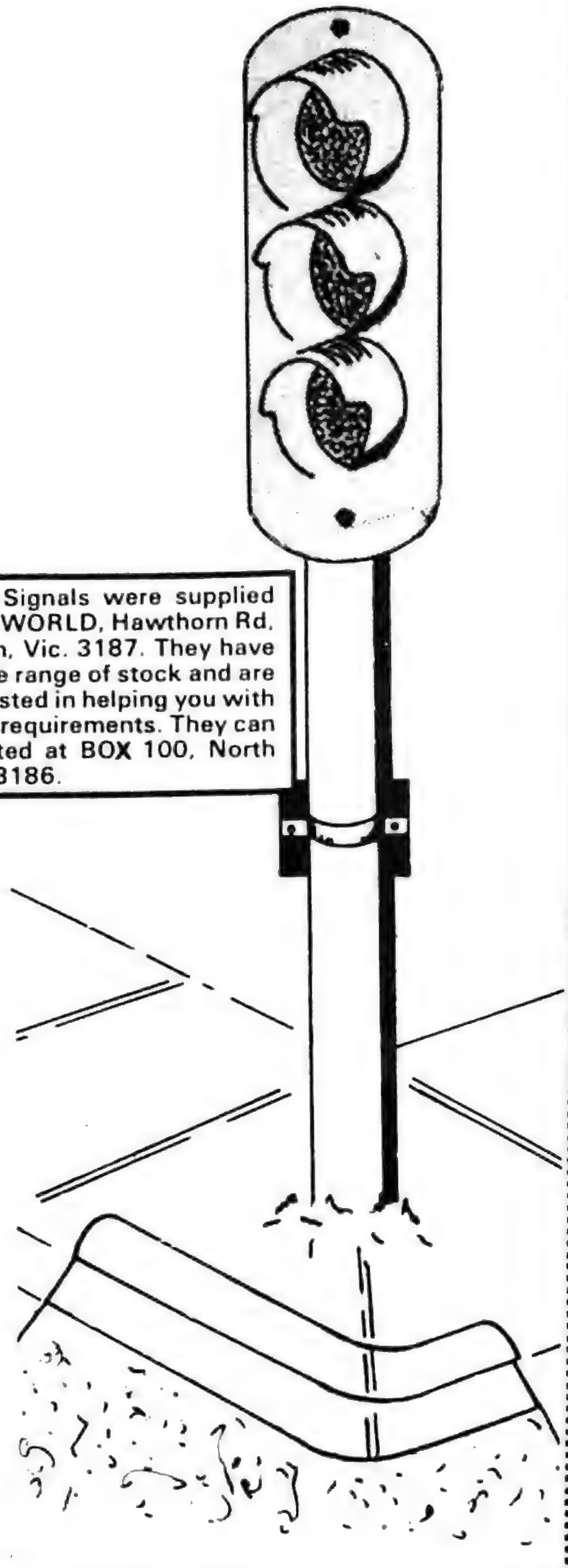
The 8 pin and 16 pin IC sockets have a 'cut-out' mark at one end and this should be placed over the dot on the board to indicate pin 1.
This will make it easier to fit the IC's around the correct way. The IC's are the last item to fit and now the board is ready for wiring to the AC power line on the train transformer and also the lamps on the BOOM GATES and SIGNALS.

WIRING THE PC BOARD



Connect the two AC lines to the solder lands positioned below the diode bridge. It does not matter which way round these two wires are connected. Near the AC input are three solder lands for the BOOM GATE lamps. The land running along the edge of the board is a COMMON line and is the earth return for ALL the lamps. Solder one lamp between the middle land and the COM. land. Solder the other lamp between the 3rd land and the COM. land.

The outputs for the signals are taken from the other end of the board. Each of the lines are identified. One line from each lamp goes to the COM. and the other line goes to the identified land. This completes the wiring.
If you require the SIGNAL lamps to be frozen to allow for the movement of traffic, a line from pin 13 and 16 should be brought out to a switch. This becomes your FREEZE switch.



Our Train Signals were supplied by: TRAIN WORLD, Hawthorn Rd, E. Brighton, Vic. 3187. They have a very large range of stock and are very interested in helping you with any model requirements. They can be contacted at BOX 100, North Brighton, 3186.

SHOP TALK

Don't look now but you are possibly aware of the absence of the PC board on the cover of this issue.
The state of the economy has been the major deciding factor in omitting the circuit boards. With the circuit boards included on the cover we were required to sell slightly more than the previous number of magazines. This target was not quite achieved and although the sales did not fall, they did not rise either.
Along with this is the rising cost of producing the magazine. In the past 6 months costs have risen a staggering 25% and this has forced us into a tighter situation.
Accordingly, I am led into a rather drastic announcement. Some readers will be pleased. Others will be disappointed.
Due to a tight economy, we have to consider ceasing distribution of the magazine through news-agents. We are losing a considerable amount of money by releasing them on a sale-or-return basis in newsagents. We have to over-supply by 30% to achieve our present sales figures and the loss has had to be subsidised by the sales of magazines through electronic shops and the supply of kits and components by mail order. But now the time has come for the subsidy to cease.
I think these facts should be laid on the table.
It is not even a matter of reducing the number of copies to each news-agent as we have no accurate feedback from any of the individual shops.
It's a catch 22 situation.
By reducing the print run the sales are also reduced because the number of shops receiving the publication is also reduced. The only sales information available to us is the broad percentage generated in each state. And these are of very little guide.

One of the least known facts with publishing involves the Return-Of-Capital from sales. No publisher makes a profit out of sales. The small percentage of the cover price which is returned to him does not even pay the paper and printing account.
It is the revenue from the advertising which keeps the product coming. But to make a profit from advertisements requires an advertising content of around 50 to 65%. This immediately halves the size of the magazine and we would be falling into the hands of the system we are so strongly fighting against if we did this.

The solution is clear. We have made an impact on the Australian market and the word has gone around. Most of the keen readers already have a subscription. But so as not to disappoint the remaining thousands of readers, we are laying it open now.
In the near future we will be going to a SUBSCRIPTION ONLY service. This means you will only be able to buy Talking Electronics from us and a selected range of electronic shops. Either way it won't cost any more than the cover price and you will be getting your copy as soon as it is printed. Distribution through the news-agents takes up to 3 weeks and the postal system takes only about 3 days. So you can see an immediate advantage for a controlled form of distribution.

You will also be aware of the increased price for this issue. From issue 5 at $1.20 the cost of each successive issue has risen 15c. By simple arithmetic this makes issue 9 $1.80. In the next three months paper will rise another 10%, wages will rise 5% and a shorter working week will be introduced. The cumulative effect of this will be something more than 20% and this is not taking into account the possible rise in postage rates!
I don't want to sound pessimistic but the only way for us to survive is to pull in the reins and provide a better control of the costs.
Because of the enormous response from readers and subscribers, we will not be going under but a drastic re-assessment of the costs is an absolute necessity. I hope you don't mind.

DIGITAL COURSE

THE AUSTRALIAN DIGITAL ELECTRONICS SCHOOL has sent us further literature on their course. They have some sample pages available for schools and these are available to teachers on request.
The course has taken on very well with our readers and the number of students enrolling each week has kept the instructor and examiner very busy. All those enrolled into the first lesson have gone onto further lessons and the standard of workmanship in the construction of the projects has neen excellent.
If you have not yet enrolled for the course, and are hesitant about sending for the course, let me say that the proof of value lies in the guarantee they offer. If you do not learn anything from the course, you can return the lessons and a refund will be made. Nothing could be more genuine. This applies to all the advertisers in TE. We stand behind all the advertisers and guarantee a satisfied customer after all transactions.

On page 47 of issue 8 we outlined the structure of the course and one point we failed to mention is the cost. At $20 per lesson, the course offers very good value for money. The kits of components are included in the price and the finished projects are yours to keep.
The preliminary test on page 62 of issue 8 should be sent to the school so that an initial assessment can be made. This will be returned together with lesson 1 and the kits of components. Don't let time slip by. To start now is a step in the right direction.
You will be very pleased you did.

YOUR ELECTRONICS COURSE

Two more couse Syllabi have been sent to us and are even more scant than the others. I ask you. What is the use of studying an IC MULTIMETER? or an experiment on the limitations of a CRO? How would you like to examine the range of digital IC's or compare the contents of an integrated circuit with discrete-component circuits.
Obviously the originator of a course like this has never touched an IC and has failed to realise the difficulty in obtaining information to satisfy these requirements. An experiment to show the limitations of a CRO would take enormous research, so what are they aiming at?
A topic such as the study of timing circuits sounds complex. What they mean is: THE 555 AS A TIMER!
Course outlines such as this are far too vague and too demanding. This is the type of requirement expected at MASTERS level. We want to break down some of these courses into their understandable parts. We still need more information to work on, so please send in any list of topics or course details for the course you are studying.

TWO NEW SHOPS

Two new shops have recently opened and are carrying Talking Electronics kits exclusively. They are also stocking a full range of magazines and PC boards.
Their range includes a number of hardware lines, tools, cases, transformers and soldering equipment. First to open was BILLCO Electronics, Shop 2, 31 Pultney St., Dandenong, Victoria, and more recently ABSOLUTE Electronics in Centre Rd., Bentleigh, Opposite Safeway, Near the intersection of Jasper Rd. Call in and see their range.

HAPPENINGS:

Apart from TE we repair a few TV's each week to use up the hoards of surplus components and the massive stock of ancient valves. It also pays the bills while TE is in its infantcy. Repairing keeps you aware of the atrocious designs of a decade ago and gives you a few laughs as well as a few head aches. Here are the few laughs:

From a serviceman who came in recently to our office:
"I've been servicing TV's for the past 23 years and this one sticks in my mind:
A lady rang up for service and when I arrived she seemed agitated... "I hope it's not an egg again." she said.
I couldn't fathom it out either so I took the back off the set and sure enough, there it was, a shiny new yolk. (yoke).

From a salesman selling solder:
It's cheaper to buy the thinner solder because the longer length will allow you to make more joints!

From out chief design engineer who was asked to repair a guitar amplifier for a lead guitarist.
The customer was emphatic that he had not touched the insides.
After further questioning, it was revealed that he had "looked inside and seen 5 valves" So he removed one of them and went to the local electronics shop and asked for "five of these."

We do a little trade work for non-servicemen. They buy colour sets out of the paper and sell them at auction. Our good friend Aussie does this. Sometimes he wins, sometimes he loses.
We repaired a Blaupunkt for him about 3 weeks ago and he carted it off to the auction about 4 days before the event.
On the day of the auction he tried the set for picture and sound. Nothing. So he picked it up and brought it back to us.
To our amazement, the power supply module and horizontal thyristors were missing!

Top this:
A new model Philips set came into our workshop with poor purity. After considerable testing and degaussing it was determined that the tube had gone faulty. Possibly the shaddow mask had shifted.
A new tube cured the fault but not before the customer had parted with something like $300.
Two weeks later the customer rang to say the same fault had appeared again. "It couldn't be" I said. The tube, she's a new one.
Back the set came. Very poor purity. A little diagnosis found the fault to be a degaussing thermistor. But even then the tube would not purity completely and the pure colours finished up appearing as stripes down the screen. No one could help. It was unthinkable. The chances were enormous. So we had to do it. THe tube was changed and the customer was relieved. Everyone lost out, but a lesson was learnt. You can't rely on anything. . .even replacements can fault!

NZ SUPPLIERS

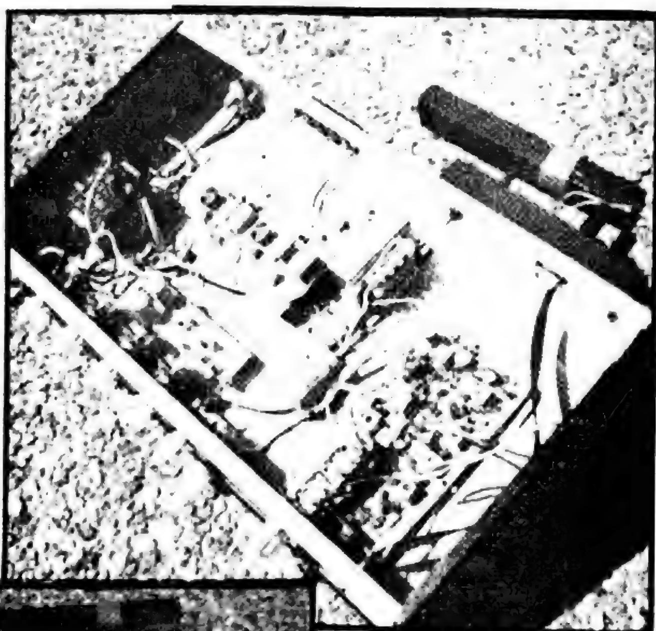
Our magazine sells very well in New Zealand and we get a number of orders from NZ readers. We now have a NZ agent: B.C. Electronics and they have a large range of our kits and magazines. Try them first and any difficult to obtain components can be purchased directly through us.

MAGAZINES and PCB's:
BC ELECTRONICS, TYRONE
6 TYRONE St.,
BELFAST,
CHRISTCHURCH,
NEW ZEALAND.

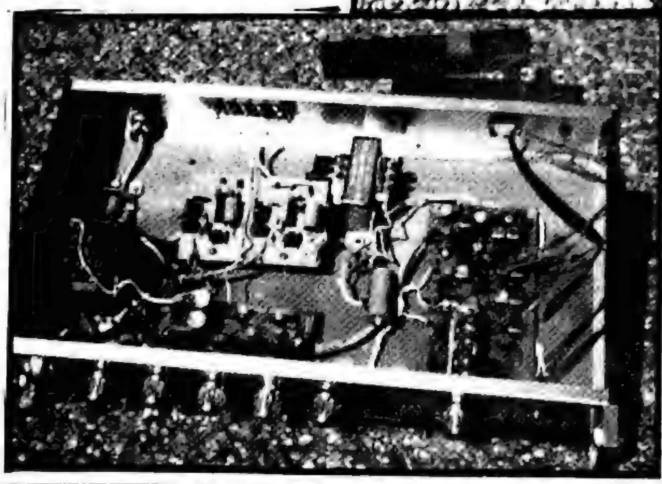
PC Boards - ONE-OFFs:
ZERO ELECTRONICS,
Box 7017,
PALMERSTON NORTH,
NEW ZEALAND.

DENTRONIC ENTERPRISES,
Box 56195,
DOMINION Rd.,
AUCKLAND 3,
NEW ZEALAND.

One off boards cost 10c (NZ) per square cm on FIBRE GLASS. Send in your artwork and they will quote for any number of boards.

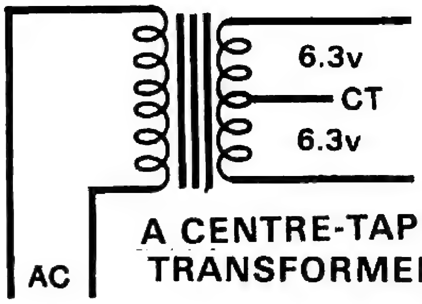


Two views of the Stereo Simplicity Amplifier made by one of our readers. He has used the one amp Power Supply and Stereo Pre-amp to amplify a tuner module he already had in his parts box.

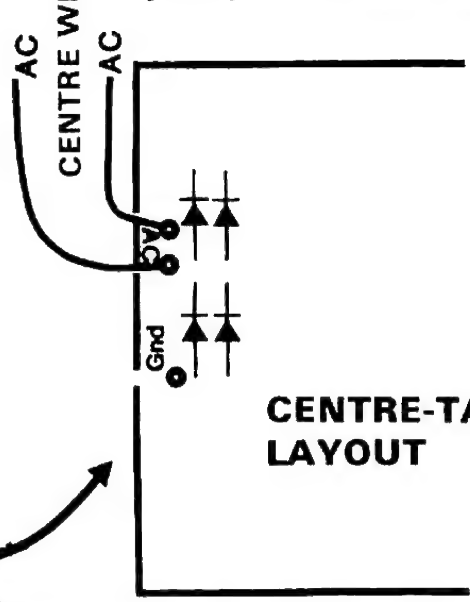


WIRING A CT TRANSFORMER

Two of the transformers we have suggested for the LOGIC DESIGNER project are CENTRE-TAPPED types.
Take the case of the 2851 transformer. This is a 12.6v centre-tapped transformer. This means it is exactly the same as a 12.6v winding which is tapped in the middle. It does not mean each side of the centre lead will produce 12.6v. In fact each half of the winding will produce only6.3v and this is a trap for many a constructor. Take the example of the 2840 transformer. It is a 9v centre-tapped type. Each half of the output winding will produce 4.5v and this is of practically no use for any of our circuits. The transformer can only be used as a single 9v winding and the centre-tap must be cut off.
To use the 2851 for the Logic Designer project, you will need to remove the centre-tap and connect the two outer wires to the two input AC pins. Use the accompanying layout diagram to help you.
With any centre-tapped transformer, don't try making a single winding by connecting the two outer wires together. This will short out the secondary and cook the transformer.



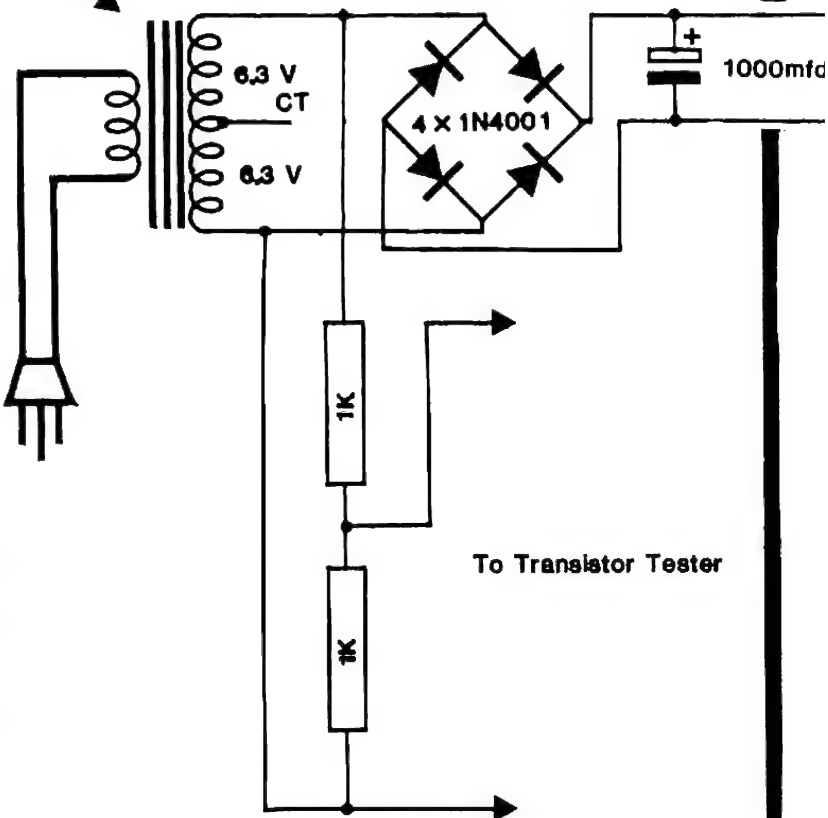
A CENTRE-TAPPED TRANSFORMER



CENTRE-TAPPED LAYOUT

The rating of a centre-tapped transformer is taken as an overall value. Half the energy will be supplied by each half-winding. The 150mA capacity of the 2851 and 2840 is the maximum continuous current. Since the half-windings cannot be paralleled up, the total current for the transformer is only 150mA.

For schools and clubs, the alternative to wiring up a mains transformer is to use a Plug Pack. These are available as a completely sealed unit and plug directly into any 3-pin socket. About 2 metres of flex is supplied to bring the 12v AC to the project. These two wires are perfectly safe to handle and are wired directly to the AC terminals of the Logic Designer.
This is the only acceptable method of creating a mains project in school clubs. And this is quite understandable. No one likes being exposed to the dangers of 240v and when you have wired a project yourself you tend to become a little blaze about the possibility of shock.



CIRCUIT DIAGRAM USING
A CENTRE-TAPPED TRANSFORMER

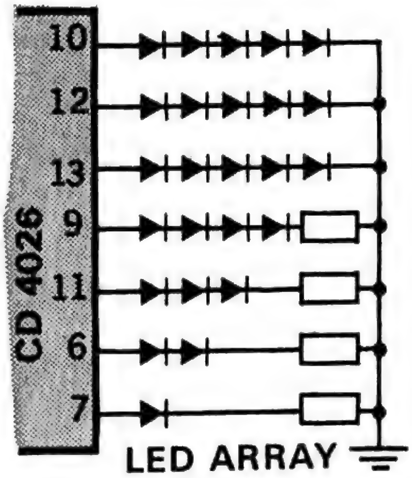
LETTERS...

We received a lot of letters for this issue and they varied greatly in content. Some of the letters have had to be reduced to give the greatest coverage and we have even presented some of the critical letters. These are the ones we like the most. The more critical the better. Constructive criticism is the fastest form of learning and if any points have escaped our letter writers, please voice your thoughts. We would like to hear from you.
A number of requests are coming from readers wishing to connect two or more projects together or modify a project to suit a particular situation. Our first letter is one of these requests:

I have built your MUSIC COLOUR and find it fascinating. My grandchildren do also.
However I would like to make a much larger display. Would you inform me how many LEDs I can add to each output. Also I am using 6 'D' cells in place of the small 9v battery to give the game more life.
I will be mounting the set of LEDs on a piece of matrix board.

N J Bouckley,
Cooktown, 4871.

The MUSIC COLOUR will operate from a 12v supply without any further modifications. This means you can use the Music Colour in the car or from a 12v plug pack for a very pleasing and bright display.
The number of LEDs can be increased to 5 per output without overloading the chip. In fact, adding or subtracting LEDs will have no effect on the heat developed in the chip. This is because the additional LEDs are placed in series on each output line and the current flowing through this type of combination is always constant.



When using a 12v supply for the MUSIC COLOUR, the output of the 4026 will require a 180R resistor if only 4 LEDs are used in one of the outputs. 330R if 3 LEDs are used, and 560R is 2 LEDs are used.

It works like this: If 10mA is required to drive one LED, a dropper resistor of about 1k will be needed to drop the remaining 10v as the LED requires only about 2v to operate. If 2 LEDs are added to the output, the dropper resistor will be 8k2 to drop the necessary 8v. If the LEDs are increased to 5, the dropper resistor will need to be only about 180R. In all these cases, the output line from the chip supplies about 10mA and the power loss is taken by the resistor. With a maximum of 5 LEDs on each output line, the Music Colour can support an array of 35 LEDs. THe final number of LEDs will depend on how much you wish to spend on this project.

I know very little about electronics, but I am keen to learn.
There is one fundamental I cannot grasp. Which way is the current flowing through circuits? It is stated that when a circuit is connected to a DC source, electrons flow through a conductor in one direction, FROM THE NEGATIVE TO THE POSITIVE POLE.
In your discussion on DESIGNING WITH TRANSISTORS, you have the current travelling from the positive of the battery to the negative (or earth). Can you clear up this point for me?

A C Barry,
Springwood, 2777.

For most electronic circuits, you need to know which way the current is flowing so that you can check the values of current and voltage with a multimeter.
The current you are measuring is called CONVENTIONAL current and this current is said to emerge from the positive terminal of the battery and disappear into the negative terminal. This convention is used for all DC circuits using globes, motors and relays such as for cars, model trains and household appliances.
Only when you need to know the actual operation of an electronic item in the circuit, do you need to apply electron flow. Such is the case when describing how a transistor works or a thyristor or a solid state rectifier bridge.
So, for your case, Conventional current flow applies. A multimeter reads conventional current (even though it may may contain diodes in some of its ranges). Even electronic multimeters such as digital multimeters or FET multimeters read conventional current.

I am a regular reader of your magazine. Its advantage over other electronic magazines is in the balance between theoretical and practical instruction.
I would like you to consider my suggestion. It would be good if some time in the near future, you could design a hypothetical computer expressly for Talking Electronics and write about every phase of its operation and organization. It would give the readers a chance to find out what happens deep inside a computer.

B Walker,
Moonee Ponds, 3039

A computer is on the drawing boards. The only problem is making it simple enough for me to understand.

Ed

I would like to congratulate you on producing such a good magazine. I am 15 years old and have been interested in electronics for about 2 years, but until I noticed issue 6 of your magazine, I had not seen any magazines which had projects which are of medium cost. I find it interesting to read your articles and your explanations help me to learn more about the uses of components. I agree with your statement that most magazines become very boring nearer to the end, but I am glad yours is not like this.

I hope to keep buying further issues, though it is expensive. I have found it possible to sell the PC board from the front cover when I do not want to make the project. This means the magazine can work out quite cheap.

D Niclasen,
Murrumbeena, 3163.

Quite a cunning move.

As a regular buyer of your magazine I find it necessary to subscribe. In NSW I was always able to get the magazine as I kept an eye out for it every day. On arriving in Victoria, I am amazed at how hard it is to get a copy. I have tried at only a couple of newsagents but they don't stock your magazine nor have they heard of it. The newsagents in Victoria are nothing compared to those in NSW.
As for the new circuit board idea, I think it's marvelous. Three years ago I worked for a firm in England making PCBs and can imagine the thoughts of the firms you approached. Even I would have been sceptical at first. I know how much work is required to make a single PC board and for the price you are charging, the magazine with PC board is a steal.

K S Purdy,
RAAF Base,
Laverton, 3027.

I have only bought 1 issue of Talking Electronics and I was impressed the way you have kept the number of advertisements to a minimum. I did not know that the price rose 300% because the first time I saw TE was issue number 6. But since some readers don't want to build the cover project, I think you should have some issues available without the PC board.
I also think you should show an overlay for each project with all the parts clearly marked and show where the holes are in the PC board.
One further thing I would like to suggest is to present more projects including amps and pre-amps.
Overall, it is the best electronics magazine I have ever read. Keep it up.
PS I have just turned 13.

L Zdanius,
Clifton Hill, 3068.

Great stuff from a young reader. Criticism as well as praise is greatly appreciated. Amplifiers are not digital projects and will be kept to a minimum. They don't offer very much in the way of understanding and usually one chip contains the whole amplifier and pre-amp. However they will appear from time to time and an 8 watt amplifier is one of the projects in this issue. It uses the TDA 2002 (LM 383) chip and is one step up on the 4 watt Simplicity Amplifier.

And now a letter from one of our earliest critics.

Mr Baitch first came on the scene with the recommendation of 'box' symbols for resistors. Since that time we have learnt that they are standard for electronic drawing in Technical Schools and have accepted them into our schematics. And now for this month's comments. He writes:

I have now received my issue No 8 of Talking Electronics, and like it very much. How can you be so consistently good? Your appeal to the younger (and also the not so young) electronics enthusiast must be phenominal. Your idea of providing printed circuit boards is excellent.
The only comment I have at the moment is the identification of TE with only an issue number. Neither the month nor the year appears on any of the issues. Since electronics moves very fast, the year of publication would best be tied with Volume number and a new series of issues started each year.

T Baitch,
Seven Hills, 2147.

We have a very good reason for not including a date on the cover of TE. Our material does not date. Our readers are still building projects from issue number 1 as though it were last months issue. I am sure this would not be the case if the year appeared on the cover.
We have tried to be pogressive and cover the next generation of electronics. So I feel the magazine will not be out of date for quite a few years.
We don't follow other magazine's conventions. In fact some other magazines are beginning to see the advantage of displaying only an issue number. The printed word becomes stale too quickly and you are only playing into the purveyors of obsolescence by including a date. The perfect example of this is the staleness of yesterdays newspaper.

Please find enclosed an order for a second egg timer. The first one got modified for other uses. We have a sandwich toaster that demands 2 minutes exactly, otherwise the crusts are too hard to eat. So R3 in the circuit was omitted and two flying leads soldered to the PC board. An SPST switch was mounted on the side of the Pavlova Egg and the centre contact soldered to one flying lead The two switch poles ran to alternate resistor chains and terminated at the other flying lead. Each resistor chain included a mini trim pot (2M2) for accurate adjustment to within 1 second. The result is a timer which switches '2 minutes or 3 minutes' as required by the Chief Cook. I ended up with 11M2 for 3 minutes and 7M for 2 minutes.

T S H Jones,
Port Hedland, 6721.

The Egg Timer has been a very successful project. The sales of Pavlova Magic have increased dramatically over the past few months and we have received an official recognition from the manufacturers for our outstanding contribution to the sales of this product. We have now used 6 of the shell containers in our experiments and prototypes and have 6 packs of mixture available. If any one has made a pavlova, we would be interested to know how it has turned out.
Instead of using a high value of resistance for R3, I suggest increasing the value of C1 to 47mfd and changing it to a tantalum capacitor. You could also use the low loss RBLL range of electrolytics since it is necessary to have a capacitor with very low leakage. By using any resistance over 10M you are taking the risk of never hearing the expiry beep as the charging current will be less than the leakage current!

It was only about 3 months ago that I really became interested in electronics. I had often seen magazines and kits and I wanted to try one. Well, one day I did. It was a T..... headphone amplifier and it cost me over $40. I was so shocked at the price that I was turned off electronics for a while. About 2 months ago I picked up a rival publication . I was rather fascinated by the projects (and their cost) so I bought the magazine. About 1½ months ago I bought a few more magazines to

add to the collection but was rather disappointed to find that three of them were all published by the same firm and had the same kits in a different order. By now I had spent nearly $5 on each of the publications. I had my fingers burnt and learnt a valuable lesson.
About one month ago I picked up an issue of TE and got a pleasant surprise. Only $3.75 and a PC board too.
Since then I have bought the entire 8 issues. From these magazines I have made a VU meter, a Music Colour, a Clock and a Hangman.
TE is the best magazine I have seen because it explains a great deal of the theory of electronics and ocvers each of the projects in understandable terms.
The data sections and 10 minute digital course have helped me enormously and I feel I am progressing very smoothly.
I think your PC boards on the front cover have their good and bad points. Althought I have built all three of the feature projects, I feel you are rather forced to make the project as you have already paid $2.55 for the PC board. Since you have to send in for the parts, the convenience of the board is lost. The only advantage .of the board applies to those who have a junk box where they can make up the project almost immediately.
But on the bright side, it is 40c cheaper to buy the board with the magazine and this way you can save $4 on every 10 boards!!
The advertising in the magazine is very thoughtfully positioned. The catalogues appearing in the middle of the magazine are excellent as they can be removed without disturbing any of the technical information. I like to see a magazine which is not printed on the back of advertisements.
The complete list of kits containing all the necessary components has helped me to purchase just those items I need to finish a project.
Can I make a suggestion? Any advertiser providing a coupon or page cut-out should be presented on the back of another advertiser. This way you can send for the products without losing any of the information in the articles. The best example of this is the Experimenter Parts Co., They have a complete listing of the products they stock. However the reverse side of the advertisement is usually the beginning of an article. If it were another advert. we would be more inclined to clip the page and send for the components.
Lastly you asked for ways in which TE can be improved. Apart from what I have said above, I would like to see more useful projects such as the Clock rather than so many games such as Light the LED, Hangman etc.
Thanks very much for struggling through this letter.

T Firman,
Cheltenham 3192.

Thank you for the detailed letter. I have presented it in its entirety because I know many other readers are in the same position and feel the same way you do. After they read this letter, they will say "that's exactly how I feel".

⊚⊚⊚⊚⊚⊚⊚⊚⊚⊚⊚⊚⊚⊚⊚⊚⊚⊚⊚⊚⊚⊚⊚⊚

In the latest edition of your magazine you describe the construction of a digital clock. From the notes in the text I gather it would be possible to take the SEC supply, put it through a transformer then a divide by 50 counter and pass the one-pulse-per-second signal to a set of chips to achieve the appropriate hour, minute and second readouts.
I have thought of an extension to your clock project. It is a Chess Clock.
A Chess Clock is really two clocks with a see-saw connection whereby pressing button A will stop one clock and start the other. Button B will do the reverse. This type of clock is used in Tournament Chess where players are required to make a pre-arranged number of moves in a given time. If one player should exceed that time limit. he then forfeits the game.
Additional requirments are that the clock should be portable and available for use in a chess club where a power point may not be available. Therefore it should be battery powered. As the clocks are to measure time but not indicate the time-of-day, the hours may be simply 0-5 or 0-10.
At the start of play, the clock is set to zero. After playing for a number of hours, the games are often adjourned. When this happens, they may be resumed several weeks later and the time on each of the readouts would need to be set to the time they recorded at the adjournment. This means a pre-setting facility is needed.
The accuracy of the clocks is not of paramount importance as they are usually only required to measure time for a period of several hours. In addition, it may be necessary to stop both the clocks for a short time.
Currently a Digital Chess Clock can be bought for about $135. A self-constructed unit appeals to me much more.

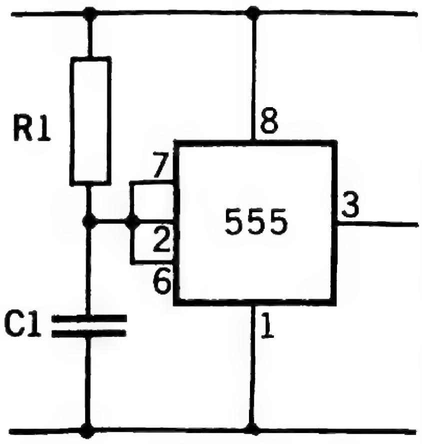
B A Minto
Springvale, 3171.

Your Chess Clock is quite a requirement. Overall it would be about 4 times more complex than our Clock project. If we get enough requests for this type of clock, we will consider offering it as a project.

Re: Issue number 7 Page 53.
I cannot see how the removal of R2 produces a square wave output with a very narrow MARK pulse.

J H W,
Kedron, 4031.

The operation of the 555 is discussed in blocks 48 and 49 of the 10 minute digital course. Because these two pages were split between two issues of the magazine, it may be difficult to follow.
Here is how it works:
Pin 7 of the 55 is connected to a transistor inside the chip and this



THE SIMPLEST 555 CIRCUIT

pins only function is to switch to ground when the voltage on pin 6 is ⅔ of the supply voltage. Connected to pin 7 is the collector of a transistor. When this transistor is turned on, pin 7 is a short circuit to earth.
With this in mind, refer to the simplest circuit for a 555.
When pin 7 switches on, the capacitor is very quickly discharged. This produces the very narrow 'MARK' pulse. The 'SPACE' pulse is determined by the charging of the capacitor via the resistor.

PRELIMINARY TEST:

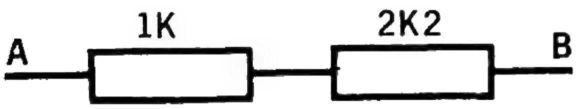
THE AUSTRALIAN DIGITAL ELECTRONICS SCHOOL
Box 334, Moorabbin, Victoria, 3189.

This test is sent in with your enrolment form and will serve as a basis to recording your improvement after completing the course. Attempt all questions. There is no time limit. Do not refer to any data books or reference material. This must be a genuine record of your present knowledge.

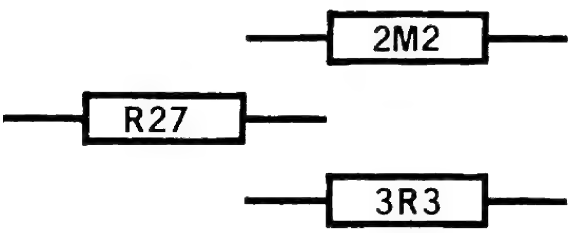
1. Identify these resistors:
(a) red - red - red - silver
(b) black - brown - black - silver
(c) brown - orange - orange
(d) silver - green - black - brown

2. What are the colour bands for these resistors:
(a) 2M2
(b) 4k7
(c) 33R
(d) R1

3. What is the resistance between A&B?



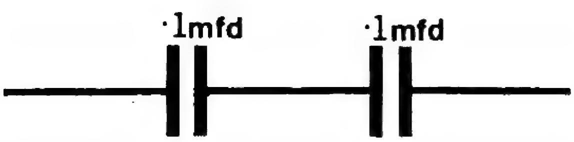
4. What is the value of these resistors?



5. What is the value of these (in mfd):

(a) 10n (b) 100n

6. What is the value of this combination:



7. If the numbers were rubbed off a CD 4017 and a CD 4001, how would you identify the CD 4001?

8. A 555 timer is in a monostable configuration. What is the effect of pin 2 on the output?

9. What is the voltage drop across a silicon diode?

10. Which segments of a 7-segment display would illuminate for the number 5?

11. What is the binary for:
(a) 32
(b) 61
(c) 87

12. Describe these:
(a) 4011
(b) 7805
(c) CD 4001, 1N 4001.

13. What do these letter stand for:
(a) PCB
(b) MMV
(c) PIV
(d) AMV
(e) RMS
(f) BCD
(g) DIL
(h) DPDT
(i) MFD
(j) LED
(k) RST
(l) GND
(m) 555
(n) CLK

14. Draw a circuit of a 555 operating at about 1kHz:

57 THE SHIFT REGISTER

AN EXAMPLE OF A SHIFT REGISTER CAN BE SEEN ON THE DISPLAY OF SOME CALCULATORS. THE NUMBERS IN THE DISPLAY SHIFT TO THE LEFT AFTER EACH ENTRY IS MADE ON THE KEYBOARD.

THESE NOTES WILL COVER A SIMPLE ARRANGEMENT USING A SHIFT REGISTER TO SHIFT HIGH OR LOW PULSES.

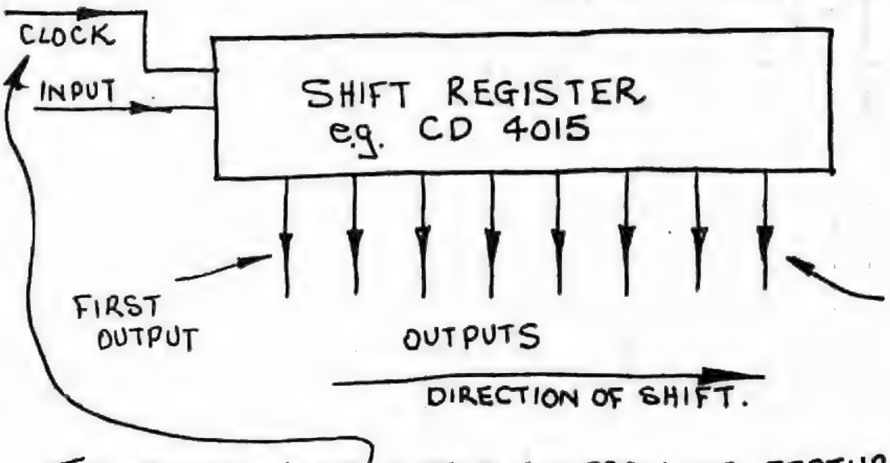
SHIFT REGISTERS FALL INTO 4 CATEGORIES:

1. SERIAL INPUT ····· PARALLEL OUTPUT ← OFTEN USED
2. " " ····· SERIAL "
3. PARALLEL " PARALLEL "
4. " " SERIAL " ← OFTEN USED

A SHIFT REGISTER CAN ALSO BE DESIGNED AS A SHIFT-LEFT OR SHIFT-RIGHT REGISTER. SOME HAVE A SELECT PIN TO SHIFT IN EITHER DIRECTION.

HOW A SHIFT REGISTER WORKS:

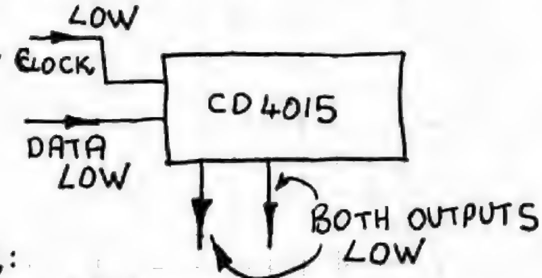
THE DIAGRAM SHOWS A SHIFT-RIGHT REGISTER WITH 1 INPUT & 8 OUTPUTS. A CD 4015 CAN BE WIRED TO GIVE THIS ARRANGEMENT.



WE HAVE:
THE CLOCK LINE
THE INPUT LINE (DATA LINE)
& THE OUTPUT LINE(S)

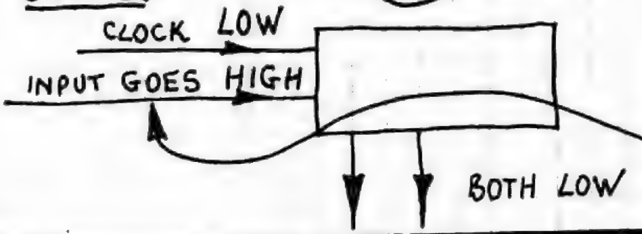
THE CLOCK LINE IS THE CONTROLLING FEATURE OF A SHIFT REGISTER. FOLLOW THROUGH THE 5 STEPS & SEE HOW IT REGULATES THE FLOW OF INFORMATION:

STEP 1:



ALL THE LINES ARE LOW. THE DATA LINE IS THE INPUT LINE & WILL PRESENT THE INFORMATION TO THE CHIP

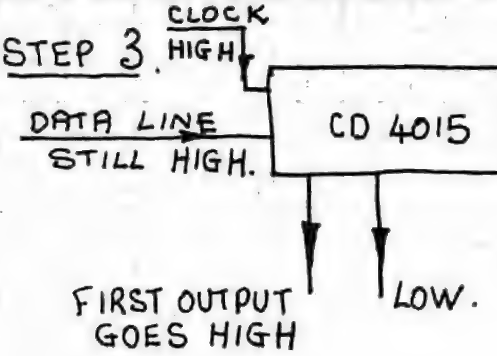
STEP 2:



THE HIGH ON THE INPUT LINE SITS READY TO BE ACCEPTED BY THE CHIP.

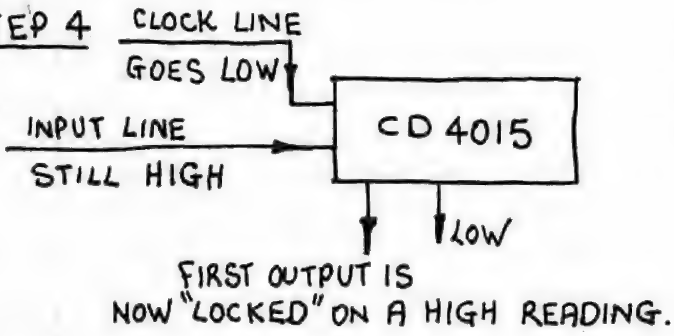
58

STEP 3.



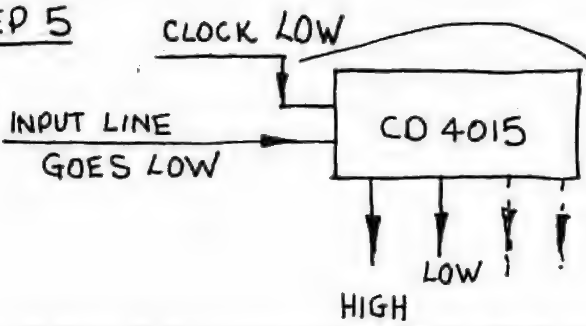
THE HIGH ON THE DATA LINE IS ACCEPTED BY THE CHIP DUE TO THE CLOCK LINE GOING FROM LOW TO HIGH. THE CHIP SHIFTS OR RECORDS A READING ON THE RISING EDGE OF THE CLOCK PULSE.

STEP 4



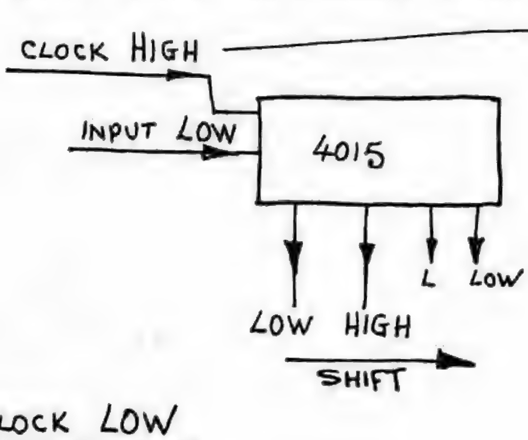
THE INPUT LINE HAS NO FURTHER EFFECT ON THE OUTPUTS AS THE CLOCK LINE HAS SEALED OFF THE CHIP. (BY GOING LOW)

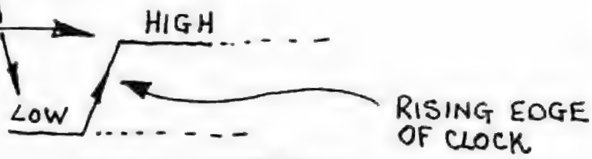
STEP 5



THE INPUT LINE CAN GO LOW, STAY HIGH OR OSCILLATE 300 CYCLES...... IT WILL NOT MAKE ANY DIFFERENCE TO THE READING ON THE OUTPUTS. THEY ARE LOCKED BY THE ACTION OF THE CLOCK LINE REMAINING IN A LOW STATE.

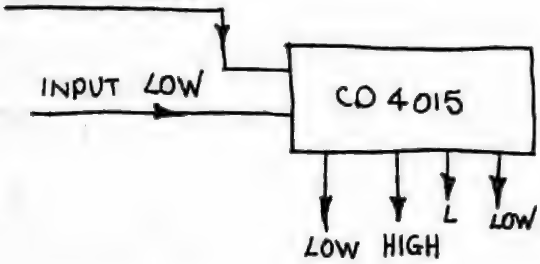
IF THE INPUT LINE REMAINS LOW:





CLOCK WAVEFORM.

THE RISING EDGE OF THE CLOCK PULSE CAUSES THE HIGH (FROM OUTPUT #1) TO SHIFT TO THE RIGHT AND THE FIRST OUTPUT NOW HAS A LOW DUE TO THE INPUT LINE CARRYING A LOW.

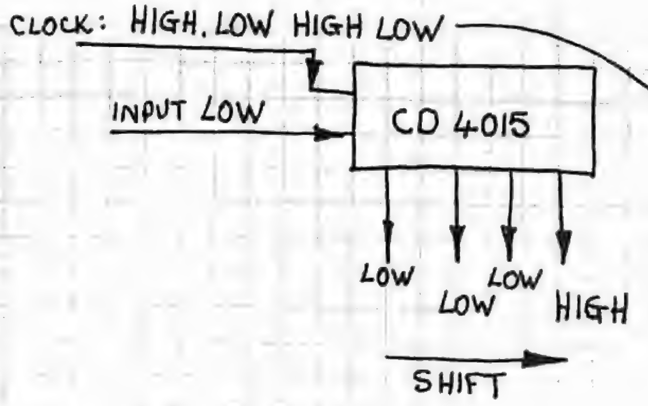


THE OUTPUTS ARE NOW LOCKED INTO A LOW: HIGH READING (THE OTHER OUTPUTS HAVE NOT YET RECEIVED ANY INFORMATION)

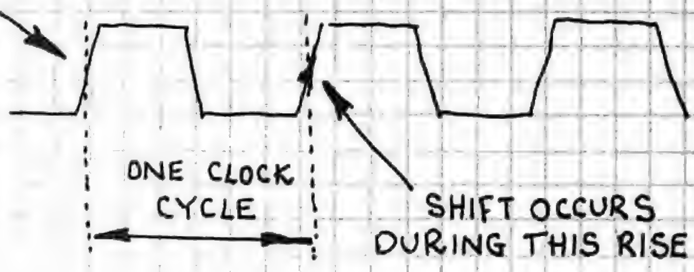
THESE EXAMPLES START WITH AN EMPTY 4015

59

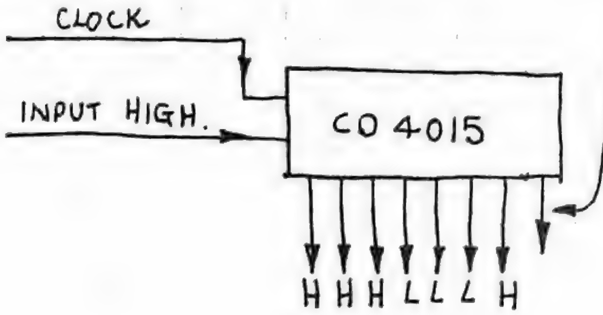
IF THE INPUT LINE STAYS LOW FOR 2 CLOCK CYCLES THE RESULT IS:



THE HIGH HAS SHIFTED TO THE 4TH OUTPUT

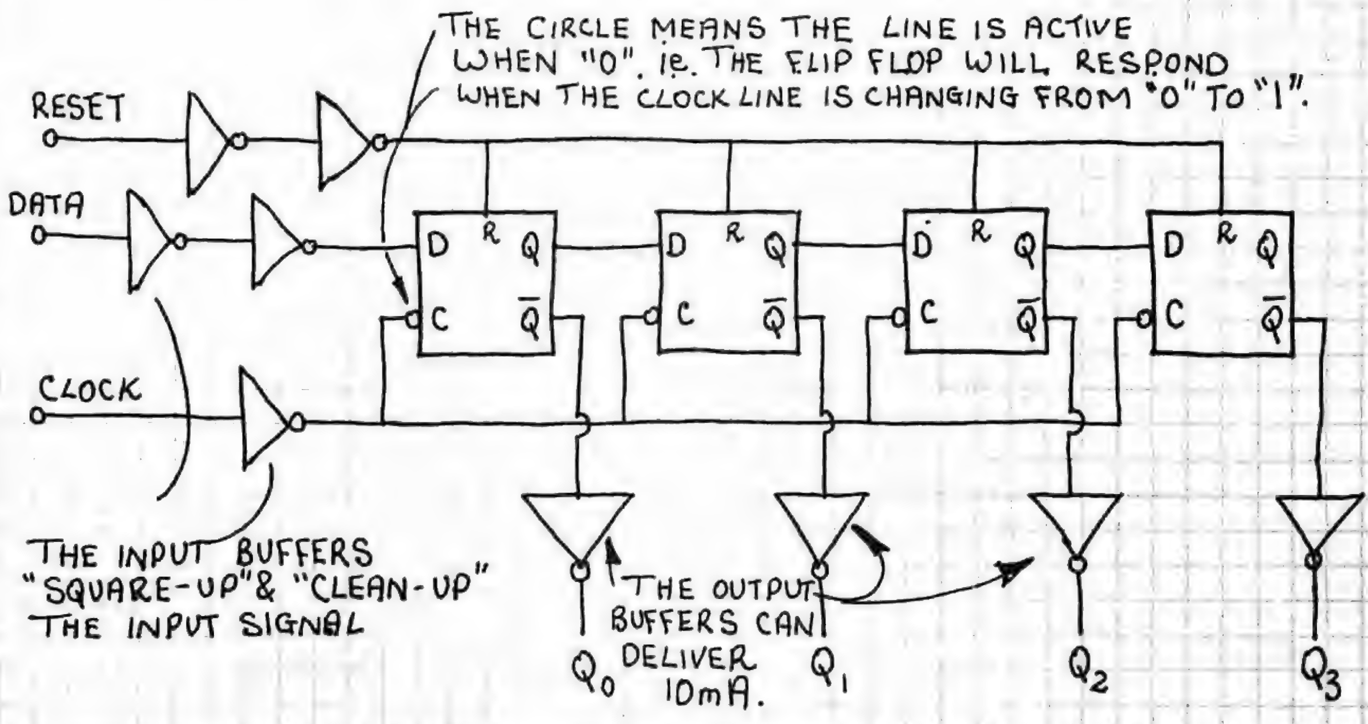


IF THE INPUT LINE NOW GOES HIGH FOR 3 CLOCK CYCLES, THE RESULT WILL BE:



THIS 8TH OUTPUT HAS NOT RECEIVED ANY INFORMATION AND WILL BE LOW. AFTER ONE MORE CLOCK CYCLE THE REGISTER WILL BE FULL. FURTHER CLOCK CYCLES WILL CAUSE THE INFORMATION TO SHIFT OUT THE END OF THE REGISTER AND BE LOST. - MORE ON THIS LATER.

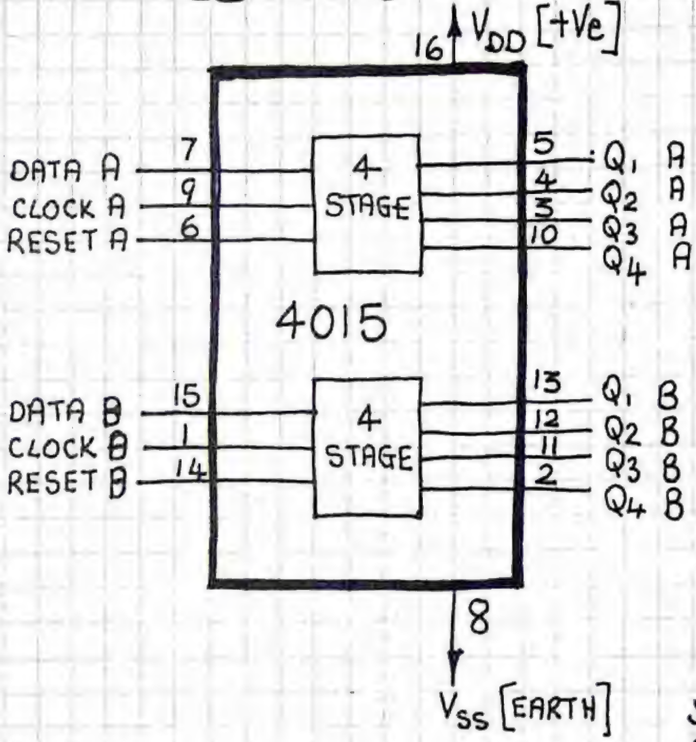
THE CD 4015 CONTAINS TWO 4-STAGE STATIC SHIFT REGISTERS HERE IS ONE 4-STAGE SECTION:



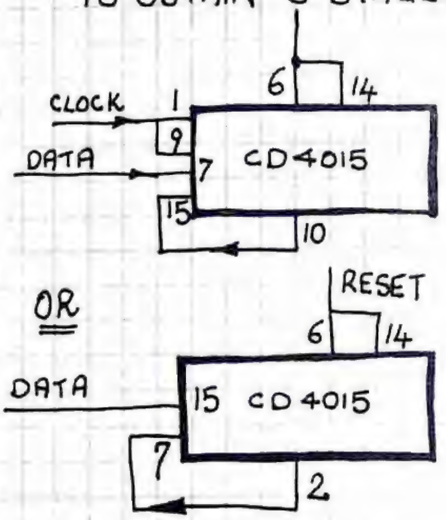
60

THE SHIFT REGISTER CONSISTS OF A NUMBER OF TYPE D MASTER-SLAVE FLIP FLOPS & DATA IS SHIFTED FROM ONE STAGE TO THE NEXT DURING THE POSITIVE-GOING CLOCK TRANSITION. THE OUTPUTS ARE "LOCKED" WHEN THE CLOCK IS LOW & THE SHIFT REGISTER ONLY DETECTS THE INPUT LINE WHEN THE CLOCK IS GOING HIGH. THIS MEANS THE INPUT DATA MUST BE PRESENT BEFORE THE CLOCK BEGINS TO RISE AND REMAIN UNTIL THE CLOCK RETURNS LOW.

CD 4015 PINOUT



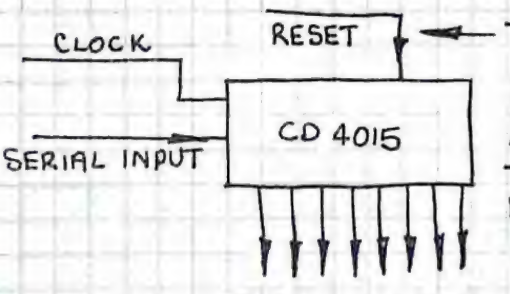
THE CD 4015 CONTAINS 2 IDENTICAL 4 STAGE STATIC SHIFT REGISTERS WHICH CAN BE CASCADED TO OBTAIN 8 STAGES:



JOINING THE 2 SECTIONS TO CREATE 8 STAGES.

SERIAL INPUT ······· PARALLEL OUTPUT.

THE PREVIOUS EXAMPLE USING THE CD 4015 SHOWS HOW DATA ENTERING THE REGISTER ON A SINGLE LINE CAN BE CONVERTED AND DISPLAYED AS 8 BITS OF INFORMATION AT A TIME. IT TAKES 8 CYCLES OF THE CLOCK TO ACHIEVE THIS & BY USING THE RESET LINE THE OUTPUTS CAN BE SET TO LOW, READY FOR THE NEXT 8 BITS.



THE RESET LINE MUST BE KEPT LOW TO ALLOW THE CHIP TO DISPLAY THE DATA.

PARALLEL OUTPUTS

IF THE RESET LINE IS TAKEN HIGH THE 8 OUTPUTS WILL GO LOW. THIS WILL HAPPEN WHEN THE CHIP IS OPERATING OR WHEN AT REST. THE RESET LINE MUST NOT BE LEFT "FLOATING". IT MUST GO TO EARTH OR POSITIVE VIA A CONTROL. (eg. SWITCH OR GATE).

My Thoughts... by cpw.

Are you innovative?
Do you like to adapt and modify an item to suit another purpose?
I do, and here's why.
One of the best areas for innovation is housing projects. The reason for this is the excessive cost of most project boxes. Sometimes the case can cost as much as the components. And I think this is going overboard.

Some may say an attractive cabinet enhances a project and hides a hundred faults. I think differently. I wold prefer to have the works exposed or at least readily accessible so that the type of components used and the layout of the circuit can be seen.
After all, most of the projects you construct for a purpose. It would be a disappointment if, a year later, you had forgotten even the type of chips which were used in the circuit!
So obviously, an expensive project case is out of the question. I would prefer to leave the project exposed rather than spend lots of money on an exotic cabinet.
This reaction possibly extends from the days when every electronic circuit was presented in a large case with the back firmly attached with myriads to tiny screws. After purchasing the equipment and taking off the back, you were utterly disappointed at seeing a couple of birds-nested transistors and a few capacitors and resistor nestled in one corner of the case. Ninety-nine per cent of the case was empty!

Stemming from this type of marketing, one generally generates a feeling that the smartest cabinets contain the poorest works. And this can still be the case (no pun intended).
Fancy equipment with flashy decals do not always come up to expectation.

So, how does this relate to us, the hobbyist?

As you have noticed with most of our projects, we have never concentrated on smart or expensive cases. These have always been left up to you.
The reason has been undercurrent. I have never had lots of money and so I could never afford to waste it. I basically think it is excessive to buy any case other than a jiffy box for most of our projects. Some case the same size as a jiffy box cost $6 to $10!

Now I come back to the first question. Are you able to adapt and modify?
Instead of paying $5 or upward for a fancy case, I am always on the look-out for a house-hold container which can be readily adapted to take one of our projects. Unfortunately I have not jet come across the perfect answer for large projects but in the smaller range I have seen at least 3 absolutely ideal containers.
You are possibly aware of the Pavlova Magic shell, which we used for the EGG TIMER. We have sold hundreds of these kits and boards. (we don't sell the Pav. mix), making this one of our most popular kits. Imagine how many Pavlova Magic mixes have been sold. The design and construction of the egg shaped shell is one of the smartest moulding I have seen. In fact the moulding is too good to throw away once the contents have been made up.
We put it to one of the best uses as an EGG TIMER and it produces a really economical project along with one free pavlova!

More and more our comsumable items are presented in a container having a value considerably more than the contents. This has to be as it is the drawcard which increases sales and puts the product to the front of the super-market shelf.
The containers are not only durable and afford perfect protection for the contents but become an eye-catching feature due to their aesthetic appearance. Why not take advantage of the market research which goes into the design and incorporate one of our projects into the container.
After all you finish up with a case costing less than the equivalent from an electronics shop and collect free contents.

I recently browsed through a chemist's shop and was amazed to see a number of potential cases. Johnson & Johnson COTTON BUDS were presented in quite a unique container. It looked like a mushroom or toadstool. The top was clear plastic and the stem was light blue. The two halves fitted together very neatly creating plenty of room inside for one of a number of projects. Very soon we will be presenting an idea in one of these.
Further down the aisle was a tooth-brush case from Nada which would make an ideal probe case. The two halves of the case are injection moulded and clip together at the middle. For less than $1.00 you will have an ideal case for one of our future projects and a free tooth-brush to replace your shaggy dog.

In many instances, nothing could be more ideal than these ready-made containers. All it takes is a little imagination and a spattering of ability to present one of the TE projects in a finished container. This can also be the case if you are able to get your hand on one of the larger containers used to house cosmetics or foodstuffs.
One brand of herbal tea is presented in a plastic container made of clear poly-styrene and has a hinged lid. One hundred tea pot bags fill the rectangular box and it usually costs about $5 for any of the three different varieties. The box alone would cost this much from an electronics shop and if anyone appreciates special herbal tea in your house-hold, you may be able to collect a full set of these boxes.

There are many similar instances of adaption and modification, even the top cap from a pressure-pak product makes a good push button holder for the QUICK-DRAW game, or a casette case for the mini frequency counter. The casette case has proven a real winner. I have been shown a completely transparent version housing a counter and it is really effective. Many readers go to great pains to present their project neatly and I would prefer to see the use of a modified case rather than buying one of the more expensive cases.
I may be doing myself out of business by saying this, but facts are facts and I think most readers will agree with this reasoning.

After all, a saving is a saving.

DIGI-CHASER

$ 15¹⁰ complete.

Now comes the exciting stage.

In this concluding part of the construction we add a memory to the project. A 1k x 1 bit memory.
Memory and computers have always scared so many constructors. We are going to show that this need not be the case. The whole concept of this project is to break down the mystery which surrounds these words. A memory chip is no more difficult to understand than a counter chip or an IC containing a set of gates.

Once its concept is understood it becomes a valuable reference to call upon.
So we have used one of the simplest and cheapest memory devices, a 2102. It has 1024 cells which can be fed information one item at a time to be stored in an array of 32 x 32 cells. Provided power is kept applied to the chip, this information will remain in the chip for an infinite period of time. A control pin is provided to get the information out of the memory.
Possibly one of the factors which makes any memory circuit look complex, is the additional chip or chips which are required to support the memory. Basically these support chips are needed to select the cells so that the information out of the memory is an exact copy of that written into it. The memory chip itself is not capable of doing this. It is purely an array of 1,000 or so cells and has no way of guiding information. The 4024 binary counter does this.
THe beauty of the layout being on top of the printed circuit board will be realized when you want to expand the memory or study the layout. Nearly everything can be seen without having to turn the board over. A few lines dive under sockets but otherwise the board is a perfect demonstrator. You will be able to follow the wiring from the counter to the memory and from the memory to the shift register.
Ideally suited for class projects or home education, the DIGI-CHASER is the first step to touching computers.
This will possibly be your first introduction to memories. And this being the case we have included a section on: How Memories Work.
To keep the Digi-Chaser simple, we have used only 64 counts for a full program. Afer all, each count has to be hand entered and it would take a very long time to enter over 1,000 counts. However nothing is wasted. All the chips are mounted on sockets and can be used at a later date for a more complex project.

Digi-Chaser has a MEMORY. You programme in SERIAL information and recall it in SERIAL. The readout is a row of 8 LEDs.

PARTS LIST

COMPLETE PARTS LIST

10 - 470R
2 - 1k
2 - 10k
3 - 100k
1 - 220k

1 - 10k mini trim pot
1 - 10n 100v greencap
1 - 100n 100v greencap
1 - 22mfd electro PC mount
1 - 470mfd electro PC mount

10 - 5mm Red LEDs
1 - 5mm coloured LED
6 - 1N 914 diodes
1 - 14 pin IC socket
3 - 16 pin IC sockets
1 - SPDT mini slide switch
4 - push buttons

1 - CD 4015BE shift register
1 - CD 4024 binary counter
1 - CD 4049 hex buffer
1 - 2102 1k x 1 bit memory
1 - battery snap
hook-up wire

DIGI-CHASER PC BOARD

PARTS FOR TONE:

1 - BC547 transistor
1 - 10k
1 - 8 ohm speaker

HOW THE CIRCUIT WORKS

Two inverters from a CD 4049 are used to produce a CLOCK OSCILLATOR. The frequency of this oscillator is adjusted via a 10k pot called the "SPEED" control. The output is fed into two buffers which are paralleled together to provide sufficient drive to operate the indicator LED and also drive 3 clock lines.

The oscillator is the synchronising feature which allows the information to pass smoothly through the system. The Counter, Memory and Shift Register must all be clocked at the same time to obtain the same sequence from the system as that which has been entered into it. To achieve this, one of the clock lines feeds a 4024 binary counter. We are using only 64 of its 128 counts and an indicator LED has been wired to output Q7 to detect the 64th count.

Six lines feed between the binary counter and the 2102 Memory chip. These are not in strict numbering order as this is not necessary. Any wiring layout to suit the printed circuit board will work. See the section on the memory to understand this.

The read/write pin 3 is normally kept high (in the read position) and a LOW on this pin will allow the memory to release information to the DATA OUT pin 12.

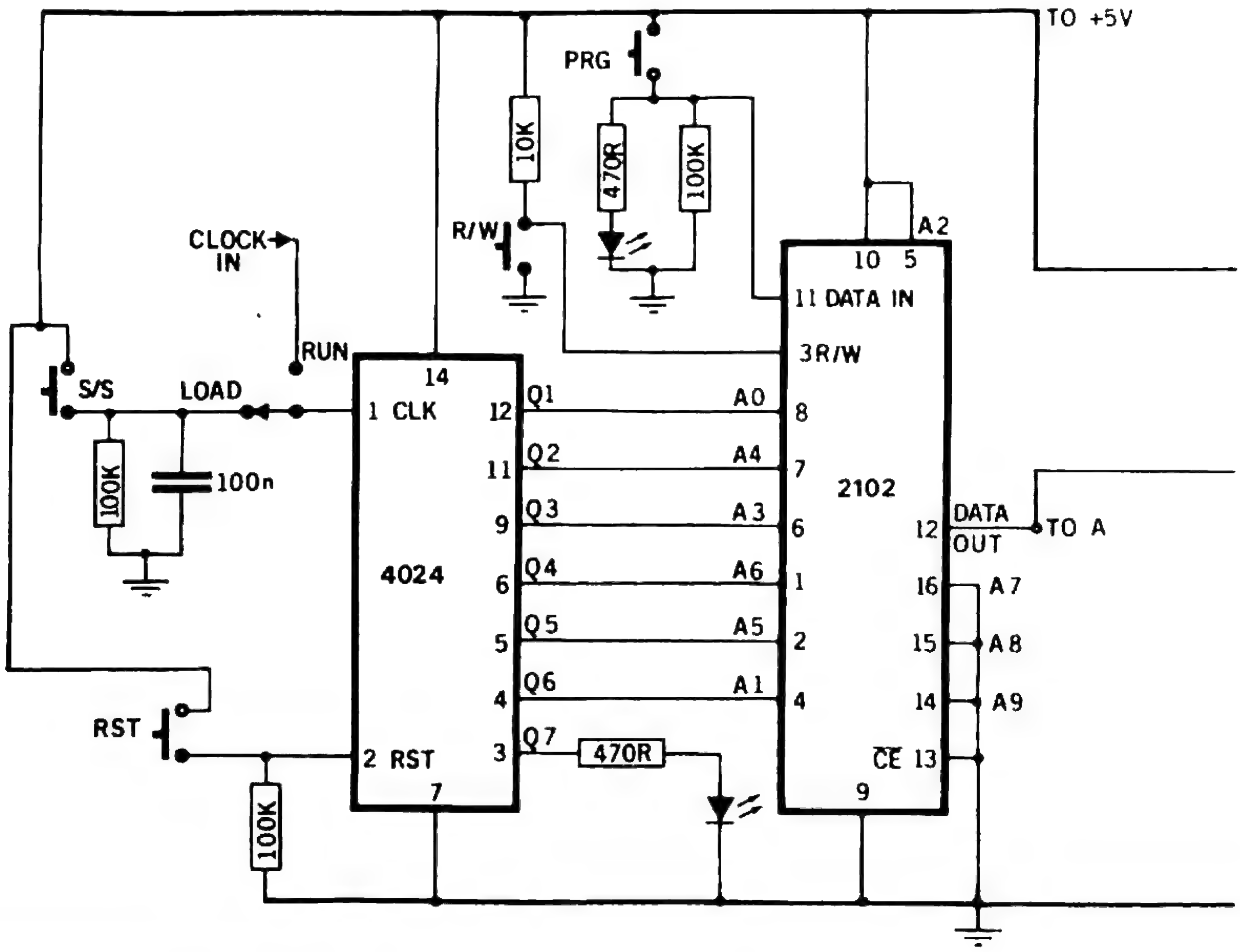
Lines A0 to A6 can be considered as "cell locating lines" and this leaves us with the need for a DATA IN pin, which is pin 11. This covers all the requirements for a memory.

The 4015 shift register contains two 4-stage static shift registers, making a total of 8 stages or 8 readouts. Data is fed in at the DATA pin (pin 15) and this processed by the shift register on completion of one of the synchronising clock pulses. The two halves of the shift register are cascaded together by connecting pin 2 to pin 7.

A resetting facility (RST) is provided on the binary counter at pin 2. This action will cause the binary counter to locate the first memory cell. A slide switch is included so that the program can be hand entered at a slow pace and then changed to the RUN position where it can be viewed on the 8 LED readout at a higher speed. The PRG switch writes a HIGH or LOW into the memory and a LED beside the switch indicates that a HIGH is being entered.

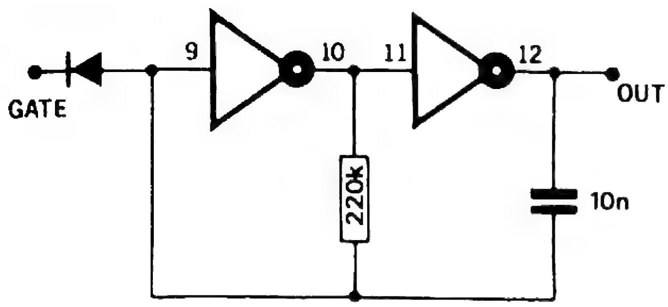
The 4th button is a stepping control to single-step the counter when hand entering information. This single-step control takes the place of the oscillator for slow clocking of the counter. The 100k and 100n components act as a debounce network. THe 4024 responds to the rising edge of the waveform and will advance one count with each press of the button.

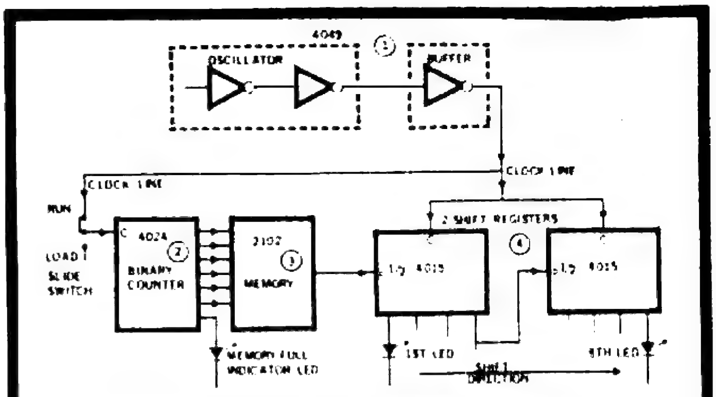
The completed project operates on a 5v rail. To achieve this, 3 diodes are placed in the positive line to act as voltage droppers and reduce the 9v to about 5v.



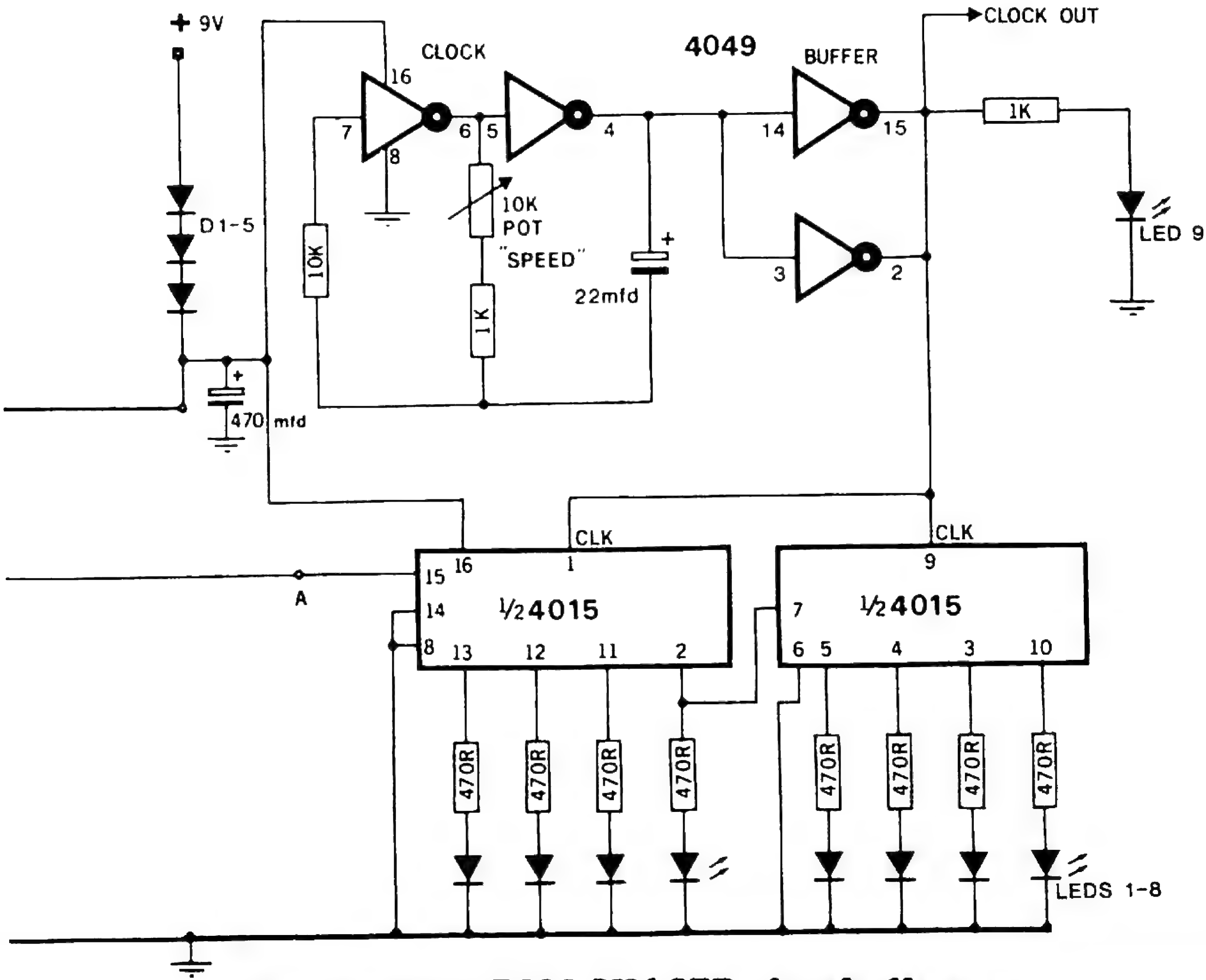
The 2102 Memory and 4024 Binary Counter are wired to give a program of 64 bits.

GATED AUDIO OSCILLATOR





DIGI·CHASER BLOCK DIAGRAM

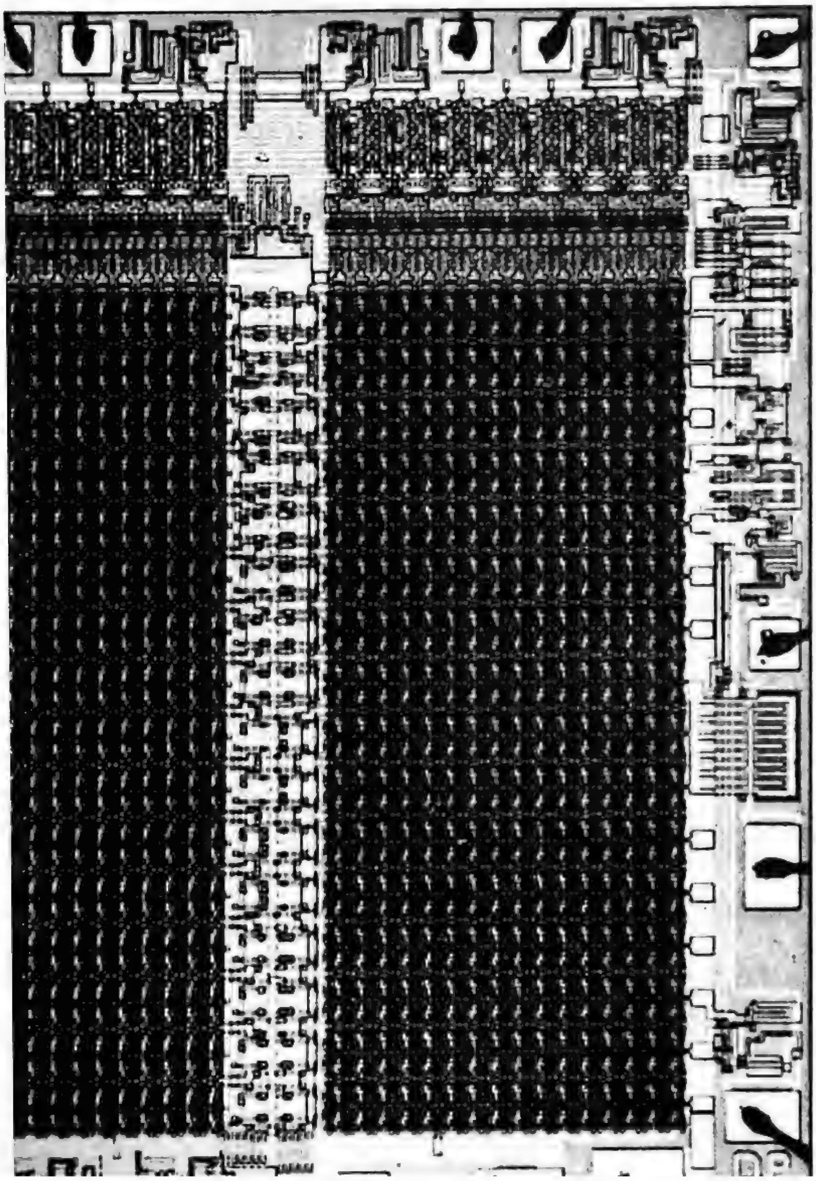


The complete DIGI·CHASER circuit diagram. Each section is fully discussed in the text.

THE 2102 MEMORY

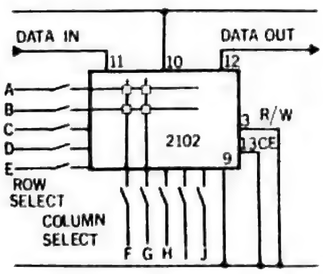
HOW MEMORIES WORK

The memory chip used in this project is a 2102AN-6 IC. This is a MOS (Metal Oxide Semiconductor) RAM (Random Access Memory) containing a 1024 - bit Static Random Access Memory. The 1024 bit memory is better described as a 1024 word x 1 bit and indicates the stored information can only be entered into the memory ONE ITEM AT A TIME, until the 1024 memory locations are filled. This is called writing into the memory. The chip will display its information ONE ITEM AT A TIME, and this is called reading the memory. The 1024 pieces of stored information are in the form of '1' and '0' indicating a HIGH or LOW and any item can be recalled by activating the associated address lines. This operation can be likened to finding a street in a street-directory using the grid reference.



The memory will supply any of the pieces of information in ANY order as indicated by its name: RANDOM ACCESS MEMORY.
The last digit (the suffix) indicates the speed of the memory. In our case we have chosen 650nS since it is the cheapest in the range. This value indicates the access time and obviously the faster access times will provide a higher speed of operation.
1,000nS is equal to a max speed of 1MHz. 650nS is about 1.5MHz, 350nS is about 3MHz and 250nS is 4MHz. Other memories have even faster access times but we need only about 100Hz!
Our project is a demonstration arrangement and not a high speed computer.

When entering information into the memory (write) the cells do not have to be filled in a logical sequence. Providing you know which row and column is the starting point of a program or sequence, the memory will read the exact same sequence at a later date.
To WRITE into a cell there are only two controls. These are READ/WRITE (pin 3) and CHIP ENABLE (pin 13). The bar across the chip enable indicates that a logic LOW on this pin will enable the chip. In other words the chip will operate when this pin is taken to deck. The memory will not function when the CHIP ENABLE pin is taken HIGH.
The READ/WRITE pin requires a logic HIGH for READ and a logic LOW for WRITE.
That is: information into the chip when pin 3 is HIGH and out of the chip when pin 3 is LOW.
Consider the R/W pin as "belonging" to the chip. In other words the chip "reads" (takes in information or "writes" (gives out information).



By closing contact A the top row of cells will be selected. Closing switch F will select the first column of cells. One bit of information can then be presented to the memory for storage. If switch G is closed instead of switch F, a cell in the 2nd column will be accessed.

Figure 1. shows a photomicrograph of a 1024 word x 1 bit 2102A static MOS Random Access Memory. The actual chip size is 2.5mm x 2.5mm and the arrangement of 32 cells x 32 cells is clearly seen.

One feature requiring clarification is the number of address lines. The 2102 has 10 address lines A0 to A9. Five of these lines select the 32 rows of cells and five select the 32 columns. These 5 lines are binary lines and via a decoding network inside the chip, they emerge as 32 lines. See Binary Numbers in the 10 Minute Digital Course block 32.
So that the 5 lines will control 32 output lines, the first line is placed at 00000.

In place of the rows of switches as shown in the diagram above, the Digi-Chaser uses a counter. As the outputs of the 4024 change from LOW to HIGH, information is entered into the memory. This will not fill the memory in a row-by-row sequence but this doesn't matter. Since the information will be retrieved in the same order as it was entered.

Refer to the DIGI-CHASER model or the layout diagram and locate the 7 lines between the 4024 counter and the 2102 memory. When you compare these lines with the block diagram you will see that only columns 1, 2 and 3 can be accessed because only the first and second inputs are connected to the 4024. The other 3 are tied LOW to prevent any of these cells picking up stray information or noise spikes.

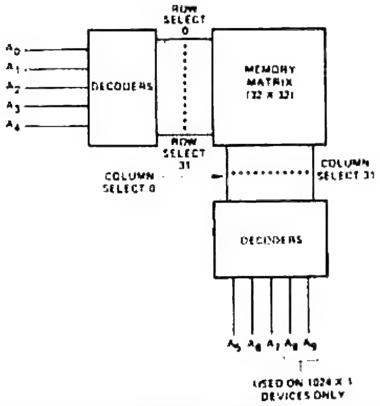


Fig 2. Simplified Memory Block Diagram.

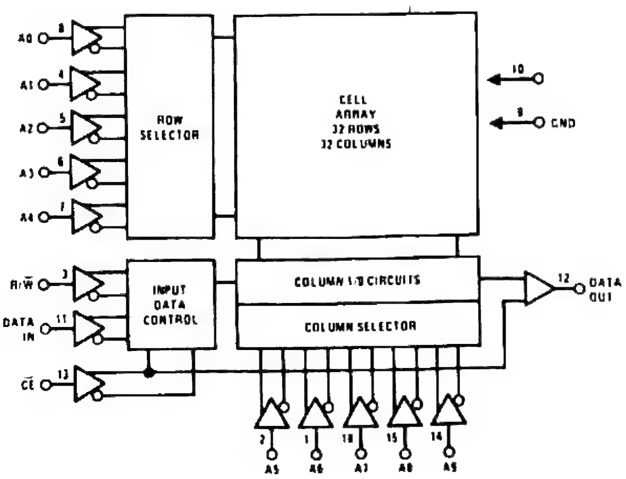
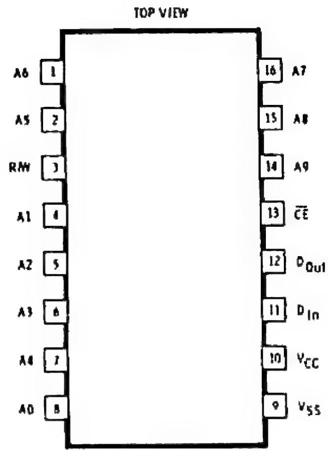
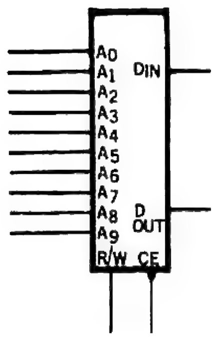


Fig 3. Block Diagram

PIN CONNECTION



2102



2102

Fig 4. Pin configuration and Logic Symbol.

The labels on the address lines are all mixed up. We have done this for two reasons. Normally Q1 goes to A0, Q2 to A1, Q2 to A3 etc. This would allow the memory to fill in a logical sequence with each row filling in turn. However this is not essential. Data can be entered into any cells in any order. When this data is to be presented to the Data OUT pin, the cells must be read in the same order. This is exactly the same as your brain. Depending on the topic you are studying, different parts of your brain will be accessed. And so it is with the 2102. To emphasise this fact, we have mixed up the address lines. Also the layout of the PC board has been carefully considered to avoid jumper lines.
The inputs to the 2102 memory are not rigidly labelled and can be re-defined. Thus we could have presented a diagram with Q1 to Q6 matching A0 to A5 (but this would not coincide with the pins as per the outline diagram and some constructors may get confused).

ASSEMBLY

Before building the final stage, remove the 4 jumper leads (3 from the slide switch and one from pin 1 of the CD 4015). These are only temporary leads for the first section.

Fit the 2 remaining IC sockets. Most sockets have some form of identification for pin 1, in the form of a cut-out or mark at one end. This should be positioned to cover the dot on the PC board.

Solder each pin carefully to avoid a dry joint or missed pin.

The few remaining components are soldered to the lands so that they sit just above the board.

A total of 6 jumpers are needed to complete the Digi-Chaser. 3 of these are made from tinned copper wire. They join pin 3 of the the memory chip (2102) to a 10k resistor. Another joins pin 2 of the CD 2024 to a 100k resistor, while the third joins the lower contact of the slide switch to the single step (S/S) switch.

3 longer jumper leads are wired as follows:

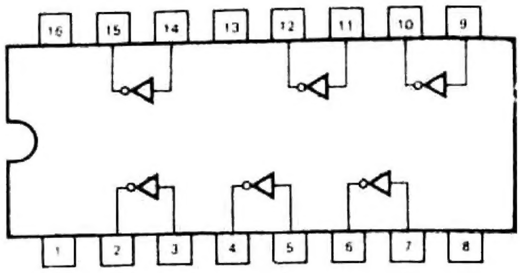
From the centre contact of the slide switch to pin 1 of the 4024 and from this same land a jumper is taken to pin 1 of the 4015 shift register.

Finally a lead from the top contact of the slide switch is soldered to the land containing the 1k "clock LED".

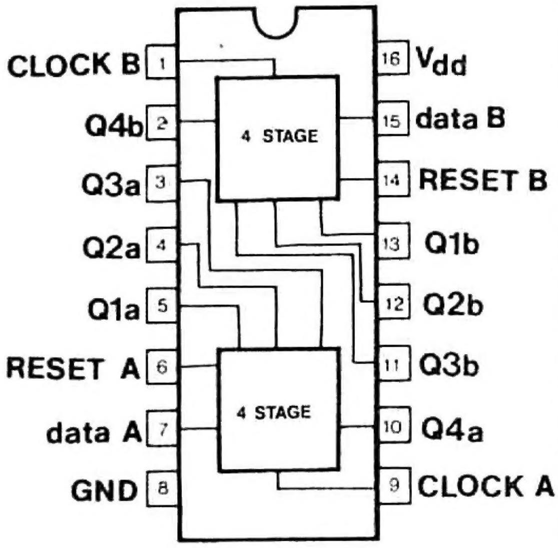
3 colourful push buttons are added to the "keyboard" section of the Digi-Chaser and these buttons can be soldered either-way-round as we are using diagonally opposite pins for the switch action.

Finally fit the 2102 memory IC and 4024 binary counter chip into the sockets as shown in the layout diagram.

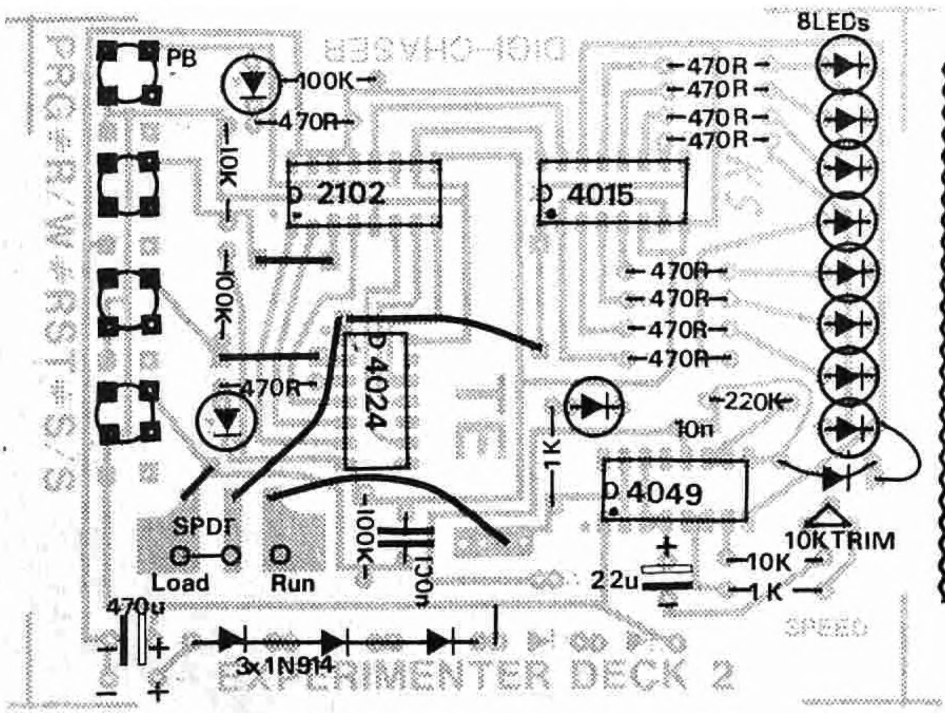
PIN OUTS



4049



4015



PARTS LIST

2nd stage:

1 - 470R
2 - 100k

1 - 100n greencap

1 - 5mm Red LED
2 - 1N914 diodes
1 - 14 pin IC socket
1 - 16 pin IC socket
3 - push buttons

1 - CD 4024 binary counter IC
1 - 2102 Memory IC

PROGRAMMING

With the slide switch in the RUN position (up), switch the unit on.
A random pattern of lights may travel across the readout. This will be entirely due to the contents of the memory from the time when it was purchased.
To clear this unwanted information, push the read/write switch "R/W" for a complete cycling of the counter. This means keeping the button pressed until the "end of memory" LED illuminates for the second time. The memory will now be clear.

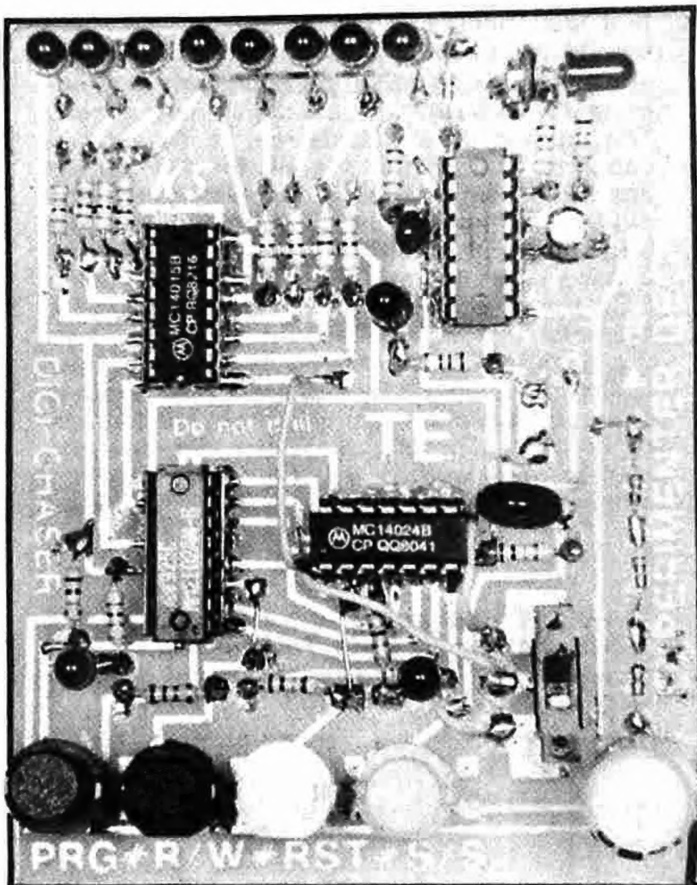
To program a sequence into the memory it will be necessary to slide the switch down into the "LOAD" position.
Push the reset "RST" switch to set the memory at the beginning of its sequence. The flashing oscillator LED will have no connection during this programming stage.

For the first exercise we will be creating a sequence of 4 LEDs on and 4 LEDs off.
To create the first illuminated LED. Push the PRG button and the PRG LED will light to show a HIGH is being programmed in the memory.
While this button is pressed, pulse the R/W switch so that the HIGH is written into the memory. Release the PRG switch. A HIGH will now be written into the first memory location.
With the R/W switch released (as per now) the memory is in a read condition. To see what has been written into the first location, pulse the single-step button (S/S) and the first LED in the readout will be illuminated.
Repeat the above 3 more times to get 4 illuminated LEDs.
(Push PRG, pulse R/W, release PRG, pulse S/S).
To programme 4 non-lit LEDs: Simply pulse R/W and single -step to next location by using the S/S switch.
Keep repeating the above sequence until the "end of memory" LED comes on. At the 64th step this LED will come on and no further information should be entered.
Switch the slide switch to RUN to recall the program.

STAGE 2.

1. **Press RST.**
2. **Switch to single step.**
3. **To program an illuminated LED: Press PRG, pulse R/W Release PRG. Single step to next location using S/S.**
4. **To program a non-lit LED: Pulse R/W, single step to next location using S/S.**
5. **Continue for up to 64 locations Counter LED will light on 64th step.**
6. **Switch to run to recall program.**

These steps are printed on the bottom of the DIGI-CHASER PC board.



TERMS:

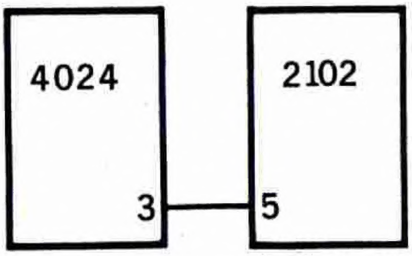
ACCESS TIME: The time required to obtain a word from the memory.
ADDRESS LINE: One of the signal lines, within a memory, used to gain access to the storage cells.
BCD: Binary Coded Decimal.
BYTE: A group of 8 bits.
CHIP: A rectangular silicon slice cut from a wafer. Most logic packages are called chips.
CLK: Clock. The clock input line.
CMOS: Complementary Metal Oxide Semi conductor.
GATE: A single logic function such as AND, OR, NAND, NOR, NOT, XOR.
H: HIGH '1'
INTEGRATED CIRCUIT: A circuit which is fabricated on a single chip of silicon.
L: LOW '0' zero.
LCD: Liquid Crystal Display.
LED: Light Emitting Diode.
MEMORY: Storage for Binary Data and programs.
MEMORY ARRAY: Cells arranged in a rectangular pattern in rows and columns on a chip.
NIBBLE: Usually 4 bits or half a byte.
PEEK: A basic function which returns the contents of a particular memory location. Also to look at the contents of memory.
PIXEL: An element of a picture such as a dot on a video graphic display.
POKE: A basic function which loads a particular memory location with a specified value. Also to enter a value into memory.
PROGRAM: A sequence of user specified instructions.
RAM: Random Access Memory.
READ/WRITE: Describes the direction of the data flow.
RESET: To return to zero.
ROM: Read Only Memory. A storage which can be written only once. The information is then fixed and cannot be changed.
RUN: Refers to the execution of a program on a computer.
R/W: Read/Write.
STATIC MEMORY: MOS memory which uses a flip flop as a storage element. It does not need to be refreshed. Contents are not lost while power is applied.

IF IT DOESN'T WORK

Firstly you have to satisfy yourself that the first section of the Chaser is operating correctly.
If you have trouble with the first section, I suggest you look over all the soldering connections as it is very easy to miss a joint under one of the IC sockets.
I found an unusual fault in one of the models sent in for repair. The constructor had used a sharp knife to clean away some of the excess solder and in the process had cut cleanly through one of the adjacent tracks. It took me quite a while to track it down as the cut was extremely fine.
Make sure none of the solder causes a bridge with the next solder land and double-check the IC sockets for pin 1.
Once you are happy with the operation of the first stage, you can finish the project.
If a fault occurs in the completed unit, you should try all the common faults as outlined above and then equip yourself with a multi-meter for some voltage and resistance checks.
The memory is a TTL device. It requires an accurate supply voltage of 5v for correct operation. Hence the need for voltage dropping diodes in the positive battery line. The tolerance on this voltage is only±.5v and if the voltage drops below 4.5v or rises higher than 5.5v, the chip ceases to give reliable operation. Measure this voltage accurately. Make sure the batteries are fairly new. As they age, their ability to maintain a voltage under load is reduced and spikes can pass from one section to another. These spikes can get into the memory and produce a HIGH which was not originally planned.

EXPANDING THE DIGI-CHASER

The Digi-Chaser can be expanded from 64 to 128 of the memory cells. This involves a slight modification to the PC board at pin 3 of the 4024 and pin 5 of the 2102.



Expanding the Digi-Chaser to 128 counts. Connect pin 3 of the 4024 binary counter to pin 5 of the 2102 memory chip.

As designed, pin 3 is connected to a light emitting diode to show when a count of 64 has been entered into the memory.
This LED will have to be removed so that the output voltage will rise sufficiently to feed the memory.

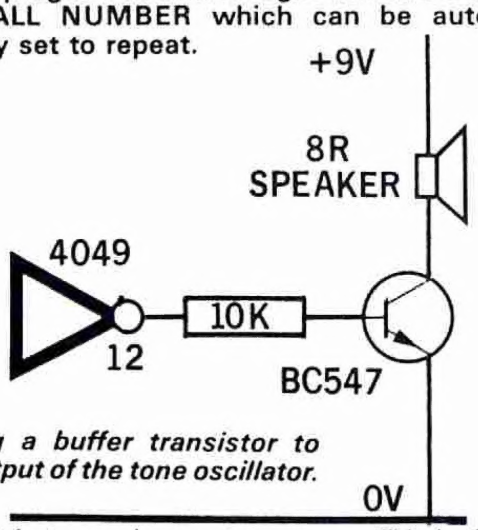
Pin 5 of the memory will be connected to this pin but firstly it must be removed from its contact with the positive rail. If you look at pin 5 you will see the land runs under the socket and to cut the track would prove difficult due to its inaccessibility. The only alternative is to cut the copper where it emerges from the chip and run a jumper around the chip. When this is done, pin 5 can be connected to pin 3.

A larger binary counter such as CD 4040 or CD 4020 could be used however they are both 16 pin chips and would require a lot of alteration to the board.

ADDING THE TONE OSCILLATOR

The gated tone oscillator can be added to the Chaser by connecting the gating diode into the circuit and providing a buffer amplifier to drive a speaker. The output of the CD 4049 is not capable of driving a loudspeaker and a simple buffer transistor will increase the volume to a listenable level.

The circuit for a common emitter amplifier is shown in the diagram and the collector load (the speaker) is taken to the 9v supply. This will provide the maximum output volume and shows a method of combining a 5v circuit with a 9v circuit.
The gating of the oscillator is controlled by the input diode on pin 9. When the cathode of this diode is taken to deck, the oscillator ceases to operate due to the input voltage being kept below half rail voltage. This diode is taken via a jumper lead to the first output of the shift register where it will be allowed to rise and fall according to the output of the register. This means the on and off tone will correspond to the value of the first LED in the readout.
The capability of this circuit is to produce a long tone or short tone similar to Morse Code. You can program brief messages such as SOS or a CALL NUMBER which can be automatically set to repeat.



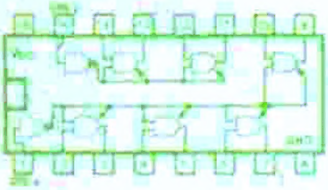
Adding a buffer transistor to the output of the tone oscillator.

I have left just enough room to say This is the conslusion of the Digi-Chaser. I hope you build it and have just as much fun and learn just as much as I did. Next project in this series will be a simple computer.

DATA

Sheet No 9

4503

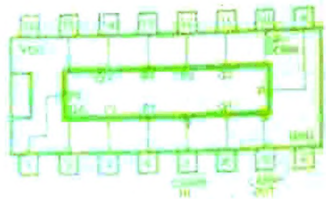


HEX NON-INVERTING
TRI-STATE BUFFER

4508

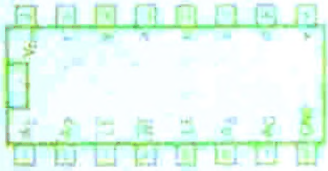
DUAL 4 BIT LATCH

4510



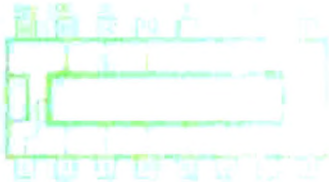
BCD UP/DOWN COUNTER

4511



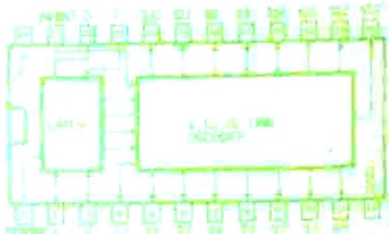
BCD TO 7 SEGMENT
LATCH/DECODER/DRIVER

4512



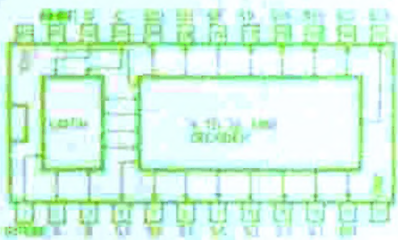
8 CHANNEL DATA SELECTOR

4514



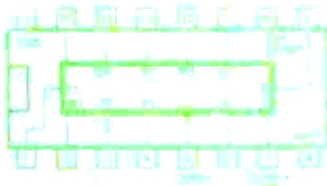
4 BIT LATCHED
4 to 16 LINE DECODER
ACTIVE HIGH

4515



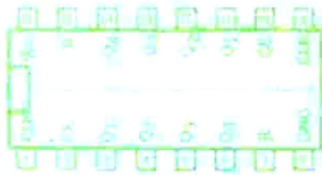
4 BIT LATCHED
4 to 16 LINE DECODER
ACTIVE LOW

4516



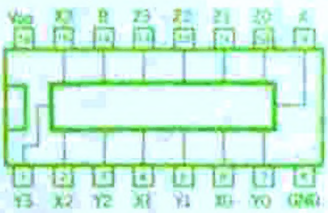
BINARY UP/DOWN COUNTER

4518



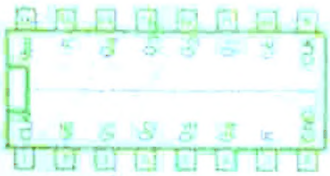
DUAL SYNCHRONOUS
UP COUNTERS (BCD)

4519



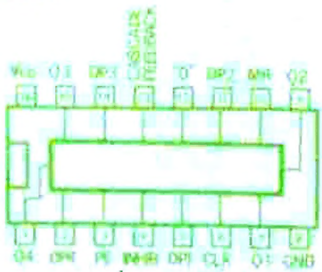
4 BIT AND/OR SELECTOR

4520



DUAL SYNCHRONOUS
UP COUNTERS (BINARY)

4522



PROGRAMMABLE DIVIDE-BY-N
4 BIT BCD COUNTER

DESIGNED and PUBLISHED by COLIN MITCHELL at 35 Rosewarne Ave. CHELTENHAM VICTORIA 3192 584 2386